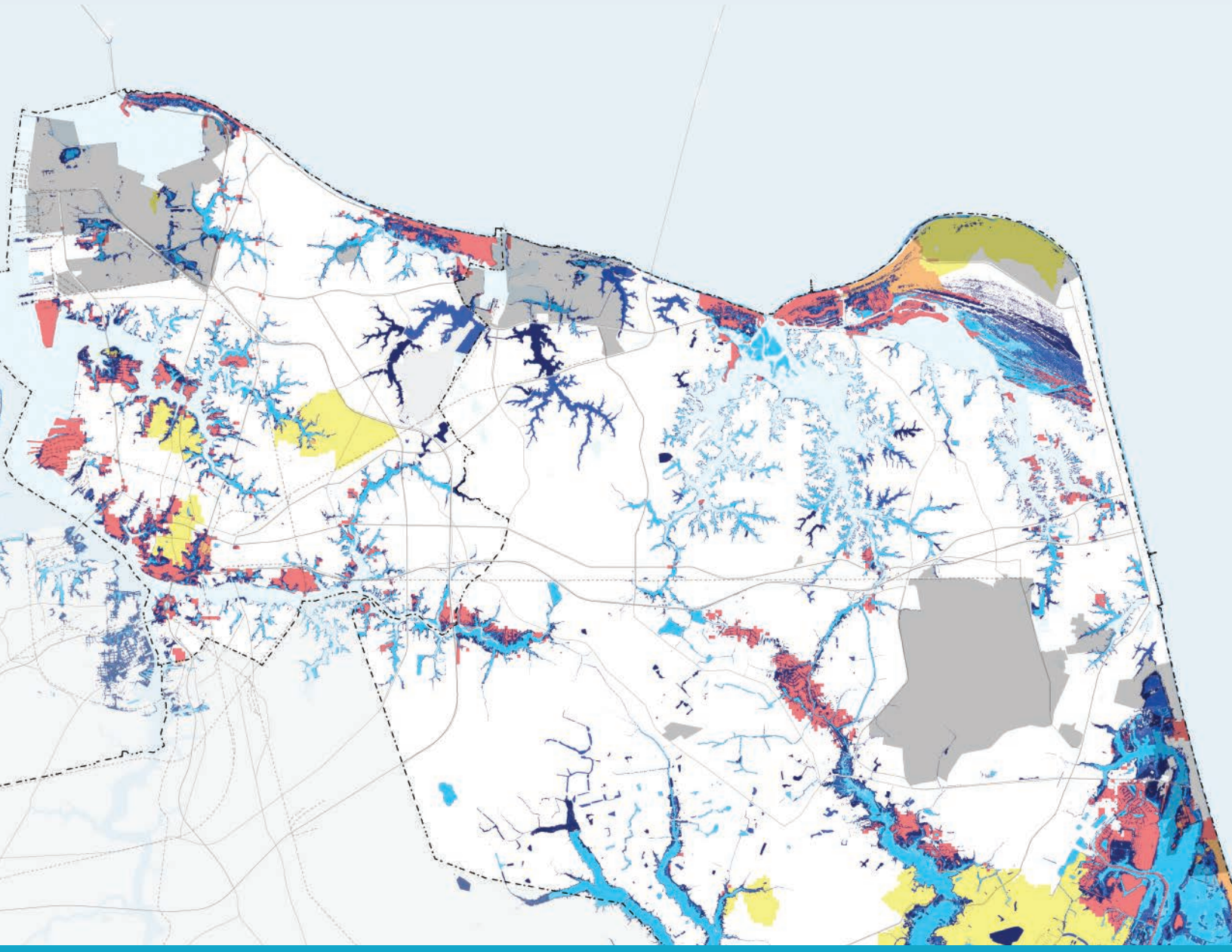
REVISED DRAFT

NORFOLK AND VIRGINIA BEACH

JOINT LAND USE STUDY



HAMPTON ROADS PLANNING DISTRICT COMMISSION

MAY 8, 2019 REVISED DRAFT

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ACRONYMS

CARSWG: Department of Defense Coastal Assessment Regional Scenario Working Group

CDBG: Community Development Block Grant

CIP: Capital Improvement Plan

CPC: Capital Planning Committee

CPLO: Community Plans Liaison Officer

CSRM: U.S. Army Corps of Engineers Coastal Storm Risk Management Study

DAR: Defense Access Road Program

DCIP: Defense Community Infrastructure Program

DCR: Virginia Department of Conservation and Recreation

DEM: Digital Elevation Model

DEQ: Virginia Department of Environmental Quality

DMME: Virginia Department of Mines, Minerals, and Energy

DoD: U.S. Department of Defense

DOT: U.S. Department of Transportation

DRPT: Virginia Department of Rail and Public Transportation

EMS: Emergency Management Services

EO: Executive Order

EPA: U.S. Environmental Protection Agency

FAA: Federal Aviation Administration

FEMA: Federal Emergency Management Agency

FHWA: Federal Highway Administration

FTA: U.S. Federal Transit Administration

FY: Fiscal Year

GIS: Geographic Information System

H&H: Hydrologic and Hydraulic

HRGEO: Hampton Roads Geospatial Exchange Online

HRMFFA: Hampton Roads Military and Federal Facilities Alliance

HRPDC: Hampton Roads Planning District Commission

HRSD: Hampton Roads Sanitation District

HRT: Hampton Roads Transit

HRTPO: Hampton Roads Transportation Planning Organization

HUD: U.S. Department of Housing and Urban Development

ICC: Increased Cost of Compliance

JEB: Joint Expeditionary Base

JLUS: Joint Land Use Study

LiDAR: Light Detection and Ranging

LRTP: Long Range Transportation Plan

MHHW: Mean Higher High Water

MOU: Memorandum of Understanding

NALF: Naval Auxiliary Landing Field

NAS: Naval Air Station

NASA: National Aeronautics and Space Administration

NAVD 88: North American Vertical Datum of 1988

NAVFAC: Naval Facilities Engineering Command

NDAA: National Defense Authorization Act

NEPA: National Environmental Policy Act

NFIP: National Flood Insurance Program

NIT: Norfolk International Terminals

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollutant Discharge Elimination System

NRC: National Research Council

NS: Naval Station

NSA: Naval Support Activity

ODU: Old Dominion University

OEA: U.S. Department of Defense Office of Economic Adjustment

ORF: Norfolk International Airport

PED: Preconstruction Engineering and Design

RWWMP: Regional Wet Weather Management Plan

ROM: Rough Order of Magnitude

SERDP: Strategic Environmental Research and Development Program

SLR: Sea level rise

STRAHNET: Department of Defense Strategic Highway Network

SWM: Stormwater management

TAZ: Transportation Analysis Zone

TMDL: Total Maximum Daily Load

USACE: U.S. Army Corps of Engineers

USBC: Uniform Statewide Building Code

USCG: U.S. Coast Guard

USFWS: U.S. Fish and Wildlife Service

USGS: U.S. Geological Survey

VDOT: Virginia Department of Transportation

VIMS: Virginia Institute of Marine Science

VMT: Vehicle Miles Traveled

WWTP: Wastewater Treatment Plant

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EXECUTIVE SUMMARY

PURPOSE

Norfolk, Virginia Beach, and the Navy installations that call both cities home face significant and growing challenges related to tidal flooding, which are only expected to worsen over time as sea levels rise. The long-term threat from increased flooding and sea level rise (SLR) will place additional risk on infrastructure that has a critical role in Department of Defense (DoD) readiness, including major roadway corridors and community assets that military personnel rely upon on a daily basis.

Coastal resilience planning in the Hampton Roads region has been an ongoing and evolving process over the past 15 years. Previous and ongoing efforts by the Hampton Roads Planning District Commission (HRPDC), U.S. Army Corps of Engineers (USACE), universities, and local governments have studied tidal, storm surge, and precipitation flooding and identified actions to address stormwater management and flood risk mitigation.

This **Joint Land Use Study** is a different kind of study. It evaluates the present and future impacts of flooding on the facilities and infrastructure in the community that directly support the Navy and redefines locality and state priorities accordingly. The JLUS is a cooperative planning process between Norfolk, Virginia Beach, the Navy, the HRPDC, and the Commonwealth of Virginia.

The Norfolk and Virginia Beach JLUS is a cooperative planning process between the Cities of Norfolk and Virginia Beach, the Commonwealth of Virginia, and the following:

- Joint Expeditionary Base (JEB) Little Creek-Fort Story
- Naval Air Station (NAS) Oceana, including Dam Neck Annex and excluding Naval Auxiliary Landing Field Fentress
- Naval Station (NS) Norfolk
- Naval Support Activity (NSA) Hampton Roads

The HRPDC is the primary project sponsor.

The JLUS sets forth 22 actions and related coordination strategies that Norfolk and Virginia Beach can implement in response to threats from flooding and SLR that aim to strengthen and enhance the Navy's ability to carry out its mission, improve the quality of life for sailors and their families, and allow the Navy to remain a major and robust part of the region's economy.

The JLUS public engagement process included over 75 stakeholder interviews, multiple focus groups, and three public meetings. The primary project phases are shown in the diagram above. A **Technical Committee** comprising city department heads and department staff, Community Plans Liaison Officers (CPLOs) from each Navy installation, and staff from other relevant agencies guided the process. A **Policy Committee** comprising elected and appointed officials, senior regional Navy representatives, the HRPDC's Executive Director, leadership representatives from the USACE, and representatives from the Commonwealth of Virginia validated the work of the Technical Committee and ensured that the interests of the primary study partners and stakeholders were adequately represented.

CHALLENGES

Within the study area, there is a high degree of interdependency between local governments, the Navy, and other infrastructure providers when it comes to connected resources. To evaluate how transportation infrastructure, community assets, and services the military and community rely upon could be impacted by flooding and SLR, three flooding scenarios were defined, based on a review of multiple sources of SLR (SLR) projections. The JLUS flooding scenarios are:

- Minor tidal flooding with no SLR (a peak water level of 1.5 feet above local Mean Higher High Water)
- 1.5 feet of SLR plus minor tidal flooding
- 3.0 feet of SLR plus minor tidal flooding

These scenarios were used to evaluate vulnerabilities to flooding with a focus on addressing chronic tidal and stormwater flooding (also referred to as nuisance flooding) issues that affect daily routines, which are expected to increase over time in the region as sea level rises.[1] Nuisance flooding is already a common occurrence in the study area, affecting access to Navy installations and community assets.

In general, the Navy depends on the region's local governments for its roadways, utilities, and many support services. Five core challenges were identified that influenced the analysis of interdependencies and vulnerabilities. The challenges include:

1. Getting to work

Over 200 miles of regional and local roadways were identified in the JLUS planning process as either primary or secondary corridors serving the Navy, including those corridors that are part of the DoD Strategic Highway Network (STRAHNET). A vulnerability analysis identified several roadways that would potentially be exposed to minor tidal flooding and SLR,[2] including sections of Hampton Boulevard, Shore Drive, and Sandbridge Road. These roads

1 The level of data needed to quantitatively evaluate frequency and depth of rainfall-induced flooding for the JLUS is not yet consistently available across the study area. The JLUS incorporated rainfall-related flooding qualitatively by utilizing historical street and property flooding observations, collected by city staff and reported by residents over several years, to identify areas that repeatedly flood during intense rainfall events (with and without high tide conditions).

2 This is based on the depth of water estimated to occur at the lowest elevation grade along each road segment.

provide direct access to installation access control points (gates). Several of the roadway segments affected have already been identified as problem areas for nuisance flooding in flooding complaint data from Norfolk and Virginia Beach. In addition, many adjacent local roads and connector streets will also be at risk.

The impacts of tidal flooding on roadways will be exacerbated by additional SLR in the future. If these routes are congested, flooded, or otherwise impeded, the ability of Navy personnel and civilians to get to work could be impacted, thereby impacting mission readiness. The conditions can result in operational inefficiencies, impact planned operations or security, and result in loss of work time. A reliable transportation network is essential for ensuring mission readiness and the smooth, efficient movement of both people and goods to and from the Navy installations.

2. Accessing community facilities and services

Roadway flooding along key corridors and in neighborhoods also limits access to community facilities that military personnel regularly rely upon, such as schools and hospitals, and life-safety services that they may require, such as police, fire, or emergency response. An analysis of community assets[3] identified 20 facilities[4] that could potentially be exposed under 3.0 feet of SLR plus minor tidal flooding. These include elementary schools, emergency shelters, police and fire stations, hospitals, waste water treatment plants, sanitary pump stations, and potable water pump stations. These assets have a direct relationship to installation and personnel readiness.

Floodproofing assets or elevating them above the floodplain will provide minimal benefit to the greater community if large numbers of residents are unable to access the facility due to roadway flooding or flood-related congestion. If access to community facilities is greatly impeded or blocked, it impacts both the ability of staff who work at those facilities to get to work and the ability of others to use those assets or services. The access analysis conducted as part of the JLUS shows that large sections of Virginia Beach and Norfolk could experience blocked or limited access to certain community assets due to flooded roadways under 3.0 feet of SLR plus minor tidal flooding.

With rising sea levels and increases in frequency and levels of roadway flooding, as well as worsening congestion as the region's population grows, current transportation nuisances could become more serious problems in the future.

3. Managing stormwater

Undersized and/or inadequately maintained stormwater infrastructure can cause or exacerbate flooding issues on roadways and adjacent properties. Each locality owns its own stormwater infrastructure, which is managed and maintained by the city's public works department. Likewise, the Navy owns and maintains stormwater management infrastructure that is located on base. However, runoff from the installations often ends up in the localities' stormwater systems, and vice versa. Varying design standards and inconsistent maintenance regimens across the network can contribute to degraded system performance in some areas.

The ability of the existing stormwater management systems to collect, convey, treat, and discharge flow will be further reduced by higher water levels at outfall locations as sea levels rise. Improvements to both municipal and on-base stormwater management infrastructure will require collaboration and coordination with multiple jurisdictional partners.

3 Community assets are broadly defined to include both life-safety and transportation elements that provide a value or benefit to the Navy installations, military service members and their families, and the broader community.
4 The analysis excludes water pump stations and sanitary pump stations.

More detailed modeling will be required to pinpoint where roadway flooding is caused or exacerbated by inadequate stormwater infrastructure.

4. Maintaining utility services

Infrastructure providing utilities such as power, water, and wastewater is critical for maintaining operations on a military base. These networks are provided by the cities and other sources outside of the installations. Any disruption to the utility network infrastructure from current or future flooding could significantly disrupt military operations. Facilities located in vulnerable locations may face additional challenges due to flooded roadways that limit access for repairs. Both cities and the Hampton Road Sanitation District (HRSD) are actively working to address system-wide vulnerabilities, further emphasizing the importance of reliable and resilient utility networks.

5. Coordinating between jurisdictions

Virginia Beach and Norfolk both interact regularly with Navy representatives. However, in most cases, collaboration that occurs today is driven by project-specific needs of each city or the Navy. There is a lack of formalized coordination, which makes partnering on larger, regional-scale projects and strategies more challenging. Routine leadership changes that occur with the Navy and elected officials can also create challenges for continuity.

Effective regional planning requires coordination among federal, state, and local government agencies and the private sector. Good examples of partnering exist and can serve as a model for building on the cities' existing mechanisms for coordination with the Navy moving forward. However, a formalized, consistent mechanism for coordination, particularly about issues related to flooding, is needed.

TARGET AREAS AND GOALS

The results of the analyses led to the identification of five goals and four target areas where vulnerabilities were anticipated to have potential impacts on regional infrastructure or community assets the Navy relies upon.

Goals of the JLUS

- Reliable and resilient access routes for DoD personnel
- Adequate and well-maintained stormwater management systems
- Reliable and resilient utility networks
- Effective and institutionalized coordination, cooperation, and collaboration at multiple scales
- A regional prioritization mechanism for resiliency initiatives

Sub Area 1 – Priority Issues ▸ Infrastructure reliability and access to NS Norfolk and NSA Hampton Roads. Home to both NS Norfolk and NSA Hampton Roads, this area has the highest number of miles of roadway that could potentially be flooded under the 3.0 feet SLR scenario. The Hampton Boulevard corridor is a key connection between NS Norfolk and downtown, as well as the many residential neighborhoods to the south of the installations.

Sub Area 2 – Priority Issues ▸ Shore Drive flooding and underperforming stormwater systems and flooding at JEB Little Creek. Central infrastructure vulnerabilities include roadway flooding along Shore Drive and stormwater management infrastructure that may be contributing to flooding at JEB Little Creek.

Sub Area 3 – Priority Issues ▸ Flooded roadways and blocked access between JEB Little Creek and JEB Fort Story and adjacent neighborhoods. This area provides a critical connection between both properties and between the northwestern and northeastern halves of Virginia Beach. Parts of this area will potentially be cut off from access due to flooded roadways under the 3.0 feet of SLR scenario, thereby eliminating access to JEB Fort Story, neighborhoods flanking Shore Drive, and nearby community assets.

Sub Area 4 – Priority Issues ▸ Flooded roadways and blocked access on Sandbridge Road and Dam Neck Annex. This area includes sections of Dam Neck Road and Nimmo Parkway, both of which provide important east-west connections between the western part of Virginia Beach and the coast and links NAS Oceana to Fentress Airfield, an auxiliary landing field located in Chesapeake. When Sandbridge Road floods, the road is closed, and public traffic is re-routed north through Dam Neck Annex. This creates security challenges for the base related to force protection.

The four target sub areas and JLUS flooding scenarios are shown in **Figure ES-1**.

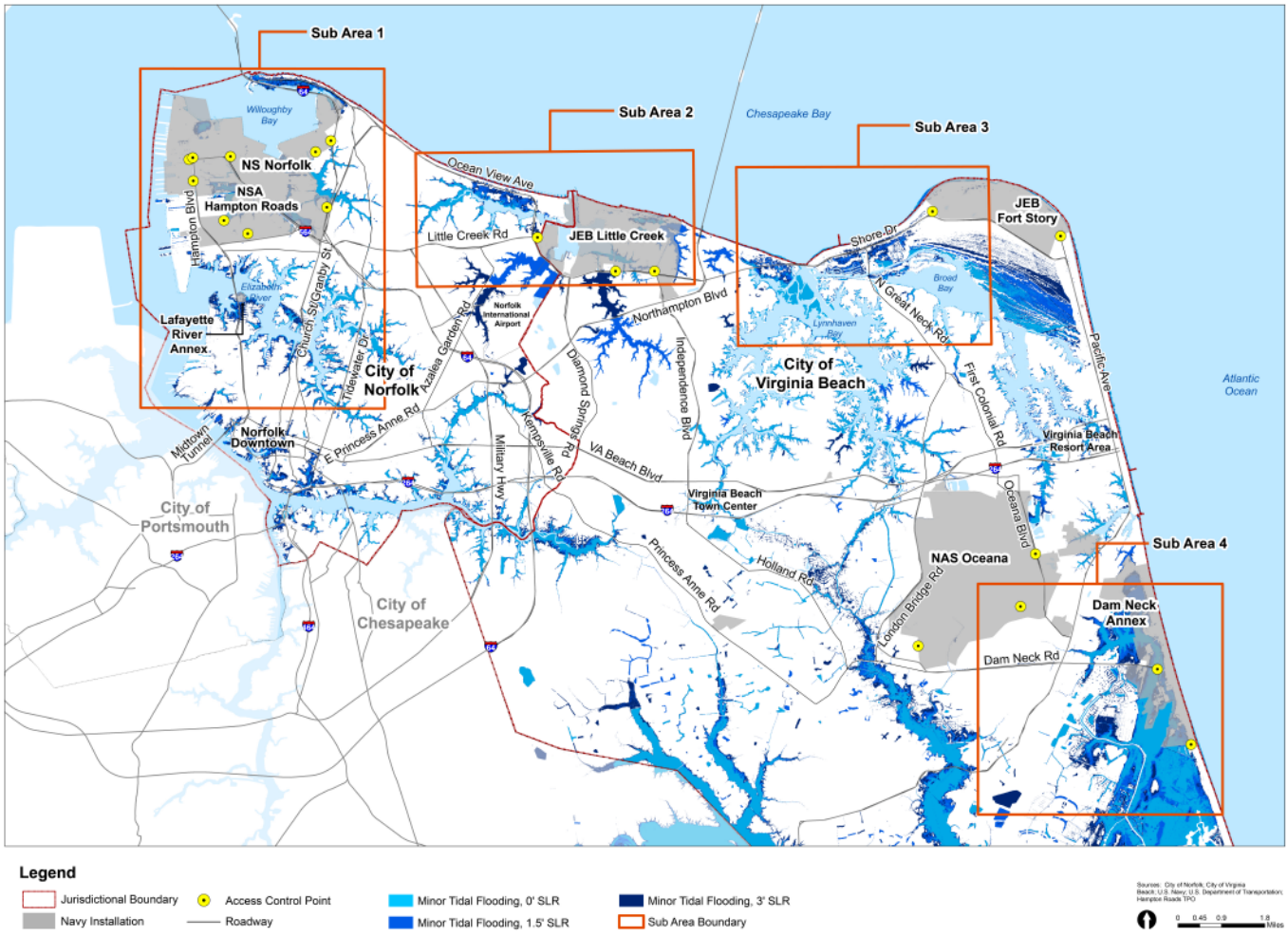

FIGURE ES-1: SLR Scenarios and Target Sub Areas

ACTIONS AND STRATEGIES

The JLUS identifies 22 Actions, 23 Regional Coordination Strategies, and seven Conversations.

22 **Actions** address challenges identified in specific target areas that impact access to the installations and/or critical community facilities, stormwater and flood risk management, or utility reliability.

23 **Regional Coordination Strategies** address issues related to coordination and outreach; advocacy, policy, development regulations; and technology and data. They identify opportunities to work together more effectively by improving processes and policies that promote more consistency on issues of importance to the JLUS partners.[5]

7 **Conversations** require further discussion and exploration among JLUS stakeholders to determine whether an idea should be studied further. Conversations may lead to agreement that further study is needed or that a certain course of action should be pursued.[6]

In many instances, the Actions refer to studies and projects in need of more technical engineering analysis and coordination across jurisdictions to define appropriate and site-sensitive design solutions. In other instances, where appropriate, actions prescribe potential infrastructure upgrades that could improve existing or forecast conditions. The Actions also include relevant projects already proposed or underway by the localities or other agencies that have a direct relationship to the vulnerability analysis findings and impact on military readiness.

TOP-RATES ACTIONS AND PRIORITIES

A set of 15 criteria were established to evaluate how well each proposed Action addresses the JLUS goals and reduces overall risk to military readiness. The criteria consider *Installation Readiness, DoD Personnel Readiness, System Performance and Design,* and *Co-Benefits*. Installation and personnel readiness criteria were each given a weighting multiplier of 3 and 2, respectively, to place an intentional emphasis on Actions that support these JLUS objectives. Action scores are the primary indicator of priority for implementation.

Based on the application of the criteria, **eight priority Actions** received a score of 15 or above. These are shown in **Figure ES-2**, Priority JLUS Actions, and described in **Table ES-1**. The two highest-scoring Actions are comprehensive flood mitigation and stormwater management strategies for Hampton Boulevard and Shore Drive – both of which are primary roadway corridors serving the DoD. Each of the navy installations is represented in one or more of the priority actions. More detail about all 22 Actions can be found in the full JLUS report.

In addition to Actions, **23 Regional Coordination Strategies** are recommended by the JLUS to address coordination and outreach, advocacy, policy, development regulations; and technology and data. The need for effective and strategic collaboration among the JLUS partners is critical but also challenging: effective regional planning requires coordination among Federal, state, and local government agencies and the private sector. These coordination strategies can be pursued to improve or expand existing coordination mechanisms, promote consistency, and enable progress toward a regional framework for addressing SLR and flooding across jurisdictions.

5 Additional strategies that were discussed, but were either not identified as a priority, or that were outside the scope of the study, are included in the Appendix of the JLUS Report.
6 Conversations are described in the Appendix of the JLUS Report.

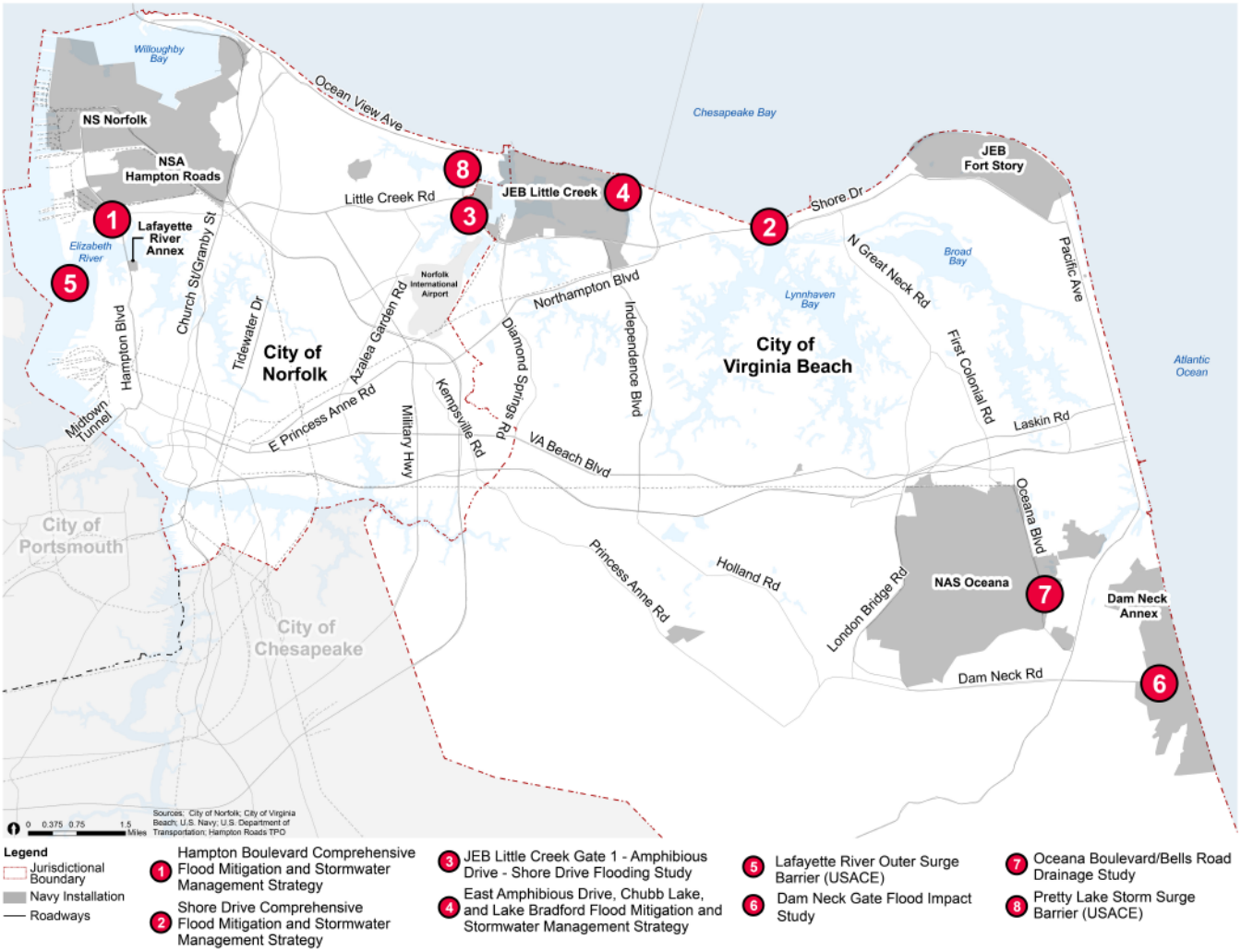

FIGURE ES-2: JLUS Priority Actions (score 15 or above)

TABLE ES-1: PRIORITY ACTIONS

#	ACTION	SCORE	DESCRIPTION
1	Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy	19	Hampton Boulevard is a major north-south roadway in Norfolk linking major economic engines for the region including NS Norfolk, NSA Hampton Roads, and the Port of Virginia. This corridor provides direct access from downtown Norfolk and the Midtown Tunnel Area to critical DoD assets, and is a primary route to connect NS Norfolk to Special Area Craney Island Fuel Depot to the west and Lafayette River Annex to the south. A comprehensive flood mitigation and stormwater management strategy is needed that considers Norfolk, U.S. Navy, and VA Port Authority infrastructure. The strategy should explore a range of measures, including increased stormwater infrastructure capacity and roadway elevation options, to address both recurrent flooding today and long-term SLR over time.
2	Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy	19	Shore Drive is a heavily-traveled east-west corridor that connects JEB Little Creek and JEB Fort Story. With an additional 3 feet of SLR, several segments of the roadway could become vulnerable to flooding, and access to JEB Fort Story from Shore Drive could be completely cut off over time. A comprehensive corridor study that focuses on the Western Shore Drive segment is needed to develop a range of options and identify a preferred approach for addressing the impacts of SLR.
3	JEB Little Creek Gate 1 – Amphibious Drive - Shore Drive Flooding Study	18	Recurrent precipitation flooding around the JEB Little Creek Gate 1 causes congestion and delays for military personnel attempting to enter and exit the base. This issue can be compounded when recurrent flooding occurs on Amphibious Drive, the only internal roadway connecting the eastern and western sides of JEB Little Creek. A joint technical hydrologic and hydraulic (H&H) modeling study between Virginia Beach, Norfolk, and the Navy is needed to determine the cause(s) of the recurrent flooding in this area and to inform the development of design solutions to manage stormwater and drainage around the gate and to account for long-term SLR impacts near the gate and along Amphibious Drive.
4	East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy	17	Tidal and storm events, combined with aging stormwater management infrastructure both on and off JEB Little Creek, regularly impact the areas south of Lake Bradford and Chubb Lake. In general, JEB Little Creek is at the receiving end of a large drainage area that includes several neighborhoods outside the installation. A coordinated and comprehensive strategy for mitigating flooding along East Amphibious Drive on JEB Little Creek, and surrounding areas, is needed to define appropriate infrastructure improvements and coordinated management and maintenance procedures.
5	Lafayette River Outer Surge Barrier (USACE)	16	Flooding from the Lafayette River during tidal and storm events is a recurring issue in the adjacent neighborhoods and along Hampton Boulevard, a primary corridor serving NS Norfolk, NSA Hampton Roads, and Lafayette River Annex. The 2018 *USACE CSRM Feasibility Study* for Norfolk proposes implementing a storm surge barrier on the Lafayette River, from Norfolk International Terminals to the Lambert's Point Golf course, as a way to manage flood risk to the Lafayette River watershed.
6	Dam Neck Gate Flood Impact Study	15	Impeded access to the Dam Neck Annex's Main Gate would have a significant impact on military readiness. Jointly pursuing an H&H study to assess the potential flood impacts of additional SLR on the Main Gate would allow the installation and Virginia Beach to take adequate measures to ensure that access is not impeded in the future.
7	Oceana Boulevard/Bells Road Drainage Study	15	NAS Oceana's Bells Road Gate is a heavily used entrance to the installation that currently experiences issues with ponding and standing water that contributes to congestion delays getting onto the base. A coordinated hydrological and hydraulic study is needed to evaluate drainage conditions and appropriate solutions for resolving the issues.
8	Pretty Lake Storm Surge Barrier (USACE)	15	Portions of the Pretty Lake watershed routinely flood during tidal/storm events, impacting the adjacent neighborhoods and roadways, including Shore Drive, a primary east/west corridor serving the DoD. The *2018 USACE CSRM Feasibility Study* for Norfolk proposes a system of measures, including floodwalls and a storm surge barrier at the mouth of Pretty Lake, to reduce flood risk in the Pretty Lake/Little Creek watershed and to protect Shore Drive.

Each strategy included in Chapter 4 was designated as a high priority by the JLUS Technical and Policy Committees. The full list of recommended regional coordination strategies is too long to include herein; however, a sample of the strategies is included below, and more detail is available in the report.

- Adopt a **Memorandum of Understanding** (MOU) among JLUS partners to commit to working together to advance and implement JLUS priorities and establish a JLUS Implementation Committee as an outcome of the MOU.
- Develop a **stormwater systems maintenance MOU** for each installation and respective locality to define ongoing roles and responsibilities for routine maintenance of ditches, culverts, and other drainage components that span locality/ Navy jurisdiction.
- Encourage Congress to **appropriate funding for the Defense Community Infrastructure Program (DCIP).**[7]
- Pursue an **amendment to the Code of Virginia and the Virginia Residential Property Disclosure Act** for mandatory disclosure requirements for flood hazard for real estate transactions (purchase and rental).
- Develop **regional guidance for incorporating flooding and SLR into city capital planning** projects to ensure that all projects adequately address flooding and SLR vulnerability, risk, and adaptation.
- Define **Geographic Information System (GIS) data sharing protocols, requirements, and points of contact** at cities and Navy to support cross-jurisdictional technical studies, analyses, and project execution.

The Actions, Regional Coordination Strategies, and Conversations recommended by the JLUS provide an actionable framework for the cities and the Navy to use as a set of "next steps" to address pressing concerns about the impact of flooding and SLR on mission readiness and broader community health, safety, and welfare, now and in the future. The JLUS process aims to facilitate an ongoing dialogue between JLUS partners that should continue far beyond the conclusion of the study itself. As conditions change and new information becomes available, the project partners should continue to incorporate that information, updating the JLUS Actions, Regional Coordination Strategies, and Conversations as appropriate to ensure that the JLUS remains an actionable, "living" document.

7 The 2019 National Defense Authorization Act, H.R. 5155 , Subtitle D, Section 2816, authorizes a defense community infrastructure pilot program that could provide funding to state and local governments to address deficiencies in community infrastructure supportive of a military installation. As of January 2019, funding has not been appropriated for the program.

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1 INTRODUCTION

1.1 PURPOSE OF THE JLUS

A Joint Land Use Study (JLUS) is a cooperative planning effort that brings together military installations and their surrounding communities to jointly identify shared challenges and strategies typically related to land use compatibility and development that currently affect, or could affect, the military mission. As expressed by the U.S. Department of Defense (DoD)'s Office of Economic Adjustment (OEA), the primary goal of the JLUS planning process is to sustain the military mission and promote community economic viability and quality of life."[1]

However, this JLUS represents a shift in focus away from traditional compatibility planning factors to specifically address current and future challenges related to tidal flooding and SLR that are already impacting the cities of Norfolk and Virginia Beach and the strategic Navy military assets that call both cities home. In contrast, a typical JLUS addresses issues like land use patterns and the extent of civilian development and how likely it is to impact the continued operational utility of a military installation. Other factors typically examined include military operational activities and requirements for the military mission, natural and cultural resources, wildlife habitat, on-and-off base air quality attainment, lighting, dust, and emissions, as well as development policies, land use regulations, and codes of local governments.[2] The 2005 Hampton Roads JLUS, which focused on air operations and land use compatibility around Naval Air Station (NAS) Oceana, Naval Auxiliary Landing Field Fentress, and Chambers Field at Naval Station (NS) Norfolk, is a typical JLUS.

The Norfolk and Virginia Beach JLUS is a cooperative planning process among the Cities of Norfolk and Virginia Beach, the Commonwealth of Virginia, and the following:

- Joint Expeditionary Base Little Creek-Fort Story (JEB Little Creek-Fort Story)[1]
- NAS Oceana, including Dam Neck Annex and excluding Naval Auxiliary Landing Field Fentress
- NS Norfolk
- Naval Support Activity Hampton Roads (NSA Hampton Roads)

The Hampton Roads Planning District Commission (HRPDC) is the primary project sponsor. The JLUS is funded by a grant from the OEA, and from local match contributions from the participating jurisdictions and the HRPDC. Other project partners are noted in Section 1.4.

1 JEB Little Creek and JEB Fort Story are used in the document to differentiate between the two non-contiguous sites that fall under JEB Little Creek Fort Story.

This JLUS focuses on the issues of tidal flooding and SLR, which were not addressed in past studies. Identified by the National Aeronautics and Space Administration (NASA) as having "one of the highest rates of relative SLR along the U.S. East Coast,"[3] the long-term threats from SLR have the potential to

1 "Compatible Use Technical Assistance." Oea.gov. Accessed February 2019. http://www.oea.gov/how-we-do-it/compatible-use/compatible-use-technical-assistance.
2 Ibid.
3 Jet Propulsion Laboratory, "NASA finds Virginia metro area is sinking unevenly." Phys.org. November, 2017. https://phys.org/news/2017-11-nasa-virginia-metro-area-unevenly.html#jCp.

services, utilities, and other community assets that are vital for both military readiness and for ensuring the health, safety, and quality of life of residents, both military and civilian. Increased risks to these assets from flooding and SLR can result in short-term or prolonged loss of access, structure loss, infrastructure damage, and other serious consequences. The high degree of interdependency between the Navy, Norfolk, and Virginia Beach around major infrastructure elements underscores the importance of these entities working together and defining a path toward a regional set of priorities.

The cities of Norfolk and Virginia Beach, together with the HRPDC and the Commonwealth of Virginia, have worked closely with the Navy and other regional partners to identify actions and strategies to reduce impacts from future SLR and tidal flooding on both military operations and the greater community. By encompassing multiple jurisdictions, this study takes a regional approach to large-scale issues that cross geographic and political boundaries. The planning horizon for the analysis conducted as part of JLUS is 2065 based on the SLR ranges used in the analysis; however, the recommended actions are intended to be implementable within the next several years, or as soon as is feasible.

The JLUS identifies 22 Actions that address identified vulnerabilities, and 23 Regional Coordination Strategies that promote partnering for implementation, including mechanisms to institutionalize collaboration that extend beyond the timeline and scope of the study itself. In many instances, the Actions refer to areas in need of more technical engineering analysis and coordination across jurisdictions to define appropriate and site-sensitive design solutions. In other instances, and where appropriate, Actions prescribe potential infrastructure upgrades that could improve conditions. The Actions also include relevant projects that are already proposed or underway by the localities or other agencies that had a direct relationship to the vulnerability analysis findings. The implementation plan described in Chapter 6 provides a work plan for the localities and Navy to advance toward implementation through existing and proposed mechanisms, including the capital improvement planning and budgeting process and improved coordination methods.

1.2 GOALS OF THE JLUS

The five overarching goals for the JLUS focus on creating and maintaining resilient, reliable networks throughout the study area to better withstand flooding conditions and promote improved coordination among JLUS partners to advance regional priorities. They respond directly to the issues defined in the analysis described later in Chapter 2. The goals are as follows:

- **Reliable and resilient access routes for DoD personnel.** A reliable transportation network is essential for ensuring mission readiness. A transportation network that is protected from future flooding and allows for the smooth, efficient movement of both people and goods to and from the Navy installations is desired. Reliable and resilient access to and from important community assets, such as fire and police stations, is essential for all community members.
- **Adequate and well-maintained stormwater management systems.** Adequate and effective stormwater management systems move water away from critical infrastructure assets like roadways, to areas properly designed to handle the flow. When stormwater systems are poorly maintained or inadequately sized, the resultant flooding or standing water can worsen traffic congestion, and in some cases, block access altogether. In some parts of the study area, stormwater management infrastructure crosses federal and city boundaries. This interdependency further highlights the importance of cooperating in the placement, construction, and maintenance of stormwater infrastructure.

- **Reliable and resilient utility networks.** Reliable, resilient utility networks are critical for ensuring military operations and protecting the health, safety, and welfare of all residents. The Navy relies on outside sources to provide power, water, and wastewater. These networks are vital for ensuring day-to-day operations at the installations and for reducing or eliminating any "down-time" as a result of a loss of service.
- **Effective institutionalized coordination, cooperation, and collaboration at multiple scales.** Although Norfolk, Virginia Beach, and the Navy already have some coordination mechanisms in place, many of the activities are not institutionalized and could be strengthened. Because leadership changes in the military are relatively frequent, it is critical to have institutionalized mechanisms governing regional coordination on multiple fronts. Established, formalized protocols and standing commitments can ensure that new leadership can be quickly brought up to speed and that regional priorities can continue to advance.
- **A regional prioritization mechanism for resiliency initiatives.** Many of the localities in Hampton Roads are already engaged in planning and implementing projects designed to combat the effects of SLR and recurrent flooding. However, there is currently no adopted mechanism in place for prioritizing resilience projects and initiatives on a regional scale. The JLUS process defines a prioritization process and evaluation criteria that could be considered for evaluating future actions to address regional resiliency priorities.

1.3 JLUS STUDY AREA CONTEXT

The JLUS study area includes the entire City of Norfolk; the portion of the City of Virginia Beach north of the City's "Green Line," as defined in its adopted Comprehensive Plan; and the JEB Little Creek-Fort Story, NAS Oceana (including Dam Neck Annex), NS Norfolk, and NSA Hampton Roads military installations. **Figure 1-1** identifies the JLUS study area.

Regional Snapshot

Norfolk and Virginia Beach are two of the 17 localities that more broadly make up the Hampton Roads region, a region of roughly 1.7 million people.[4] Norfolk, a city of approximately 245,000 residents, is bounded by large water bodies on three sides: the Chesapeake Bay to the north and the Elizabeth River to the south and west.[5] Virginia Beach is a coastal city of approximately 450,000 people. It shares its western border with the cities of Norfolk and Chesapeake, and is bordered on the north by the Chesapeake Bay and on the east by the Atlantic Ocean.[6]

According to the University of Virginia's Weldon Cooper Center for Public Service, the greater Hampton Roads region as a whole has grown at a rate of 3.9 percent since 2010.[7] Both Norfolk and Virginia Beach have also experienced population growth in recent decades. The population of Norfolk declined between 1970 and 2000, but the trend has since reversed, and the City is now experiencing modest growth. Virginia Beach, on the other hand, has experienced continual growth over the last several decades. The growing populations of both cities, and the greater Hampton Roads Region, have resulted in increased development activity, which puts additional

4 "ACS Demographic and Housing Estimates." HRPDCVA.gov. March 2017. https://www.hrpdcva.gov/uploads/docs/HR%20Demographic%20Characteristics.pdf.
5 QuickFacts Virginia Beach city, Virginia (County); Norfolk city, Virginia (County)." Census.gov. Accessed May 6. 2019. https://www.census.gov/quickfacts/fact/table/virginiabeachcityvirginiacounty,norfolkcityvirginiacounty/LFE046217
6 Ibid.
7 Reid, Whitelaw. Virginia's Annual Population Growth The Lowest In Nearly A Century. News.virginia.edu. January 28, 2018. https://news.virginia.edu/content/virginias-annual-population-growth-lowest-nearly-century

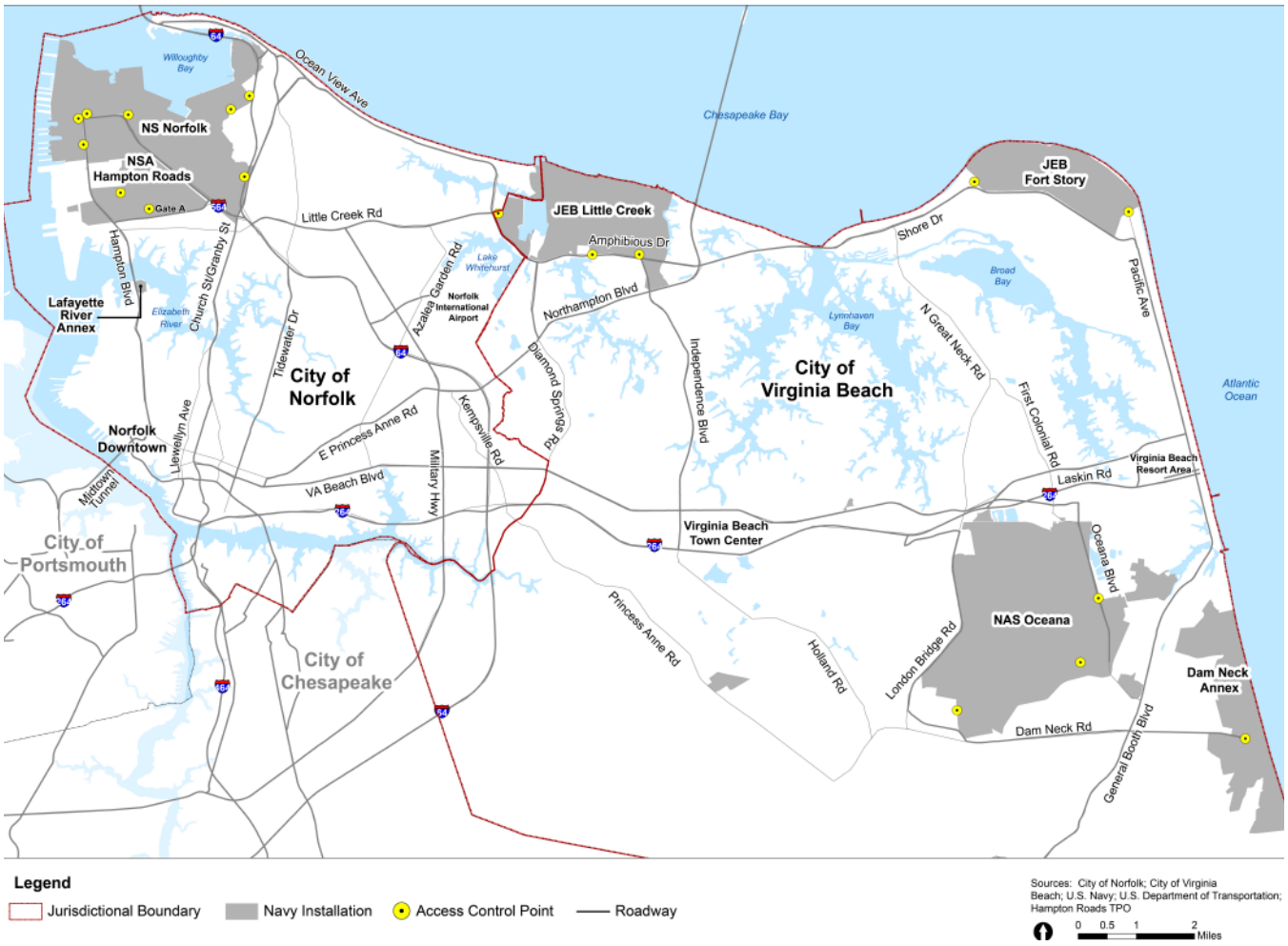

FIGURE 1-1: JLUS Study Area

pressure on public services and roadway networks. This makes regional cooperation all the more imperative, as additional SLR and flooding will exacerbate many of the issues that the region is already facing.

Regional and Local Efforts to Address Flooding

Coastal resilience planning in the Hampton Roads region has been an ongoing and evolving process over the last several decades. The HRPDC, local governments, universities, U.S. Army Corps of Engineers (USACE), and others have worked to initiate and maintain an ongoing dialogue around resiliency that continues to grow and evolve. Each locality is working to address stormwater management and to mitigate flood risk through plans, policies, and capital improvements plan (CIP) projects.

The intention of this JLUS is to expand and build upon significant previous and ongoing local, regional, and federal efforts to study tidal, storm surge, and precipitation flooding. Previous and ongoing efforts that document stakeholder input, estimate potential impacts, and set forth recommended actions to reduce risk are directly relevant to the JLUS , but are too numerous to list individually. Examples include the Sandia National Laboratories' report, *Development of*

Recent or Current Efforts to Address Resilience

Norfolk, a member of the Rockefeller Foundation's 100 Resilient Cities, was recently was awarded over $120 million in National Disaster Resilience Competition funding to support the Ohio Creek Watershed and the Coastal Resiliency Laboratory and Accelerator Center. The city also recently released *Vision 2100*, a "big picture" plan designed to guide future long-term land use policy and encourage development in areas of the city less vulnerable to SLR and flooding impacts. The city also recently adopted a new zoning ordinance, which incorporates additional standards for construction in low-lying/flood-prone parts of the City, and includes incentives for developers to build in areas (at higher elevations) where the City wants to encourage growth.

The City of Virginia Beach has undertaken a comprehensive study of SLR and recurrent flooding (the *City of Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Response Plan*), which is nearly complete. The city is also currently mapping drainage patterns in all of its drainage basins through its *Master Drainage Plan*, with the intent of using the data gathered from the study to better inform the design and implementation of targeted stormwater and flood risk management CIP projects throughout the city.

an Urban Resilience Analysis Framework with Application to Norfolk, Virginia (2016);[8] a series of technical reports put out by the HRPDC; the ongoing *City of Virginia Beach (CVB) Comprehensive SLR and Recurrent Flooding Study;* and the more recently released USACE *Coastal Storm Risk Management (CSRM) Study for the City of Norfolk* (2018). These studies, along with many others, were reviewed as part of the JLUS and provided valuable input into the analysis and identification of potential solutions.

These studies, like the JLUS, utilize the best available data and are guided by distinct study objectives and requirements. **A critical difference between this JLUS and many of the plans and studies referenced above is that this study involves working directly with the Navy to address issues specifically impacting military operations and readiness.** As a regional study covering both Norfolk and Virginia Beach, the JLUS is focused on evaluating the present and future impacts of flooding on the facilities and infrastructure in the community that support the Navy, and developing actions and strategies that the cities can implement in response to threats from flooding/SLR. Such actions would aim to strengthen and enhance the Navy's ability to carry out its mission, improve the quality of life for sailors and their families, and allow the Navy to remain a major and robust part of the region's economy.

Each of the Navy installations involved in the JLUS have distinct missions that include land, air, and sea operations. In addition to their mission, each installation provides training and other support functions serving that operational mission. The operational footprint of each installation varies, depending upon its mission. A brief summary of the mission of each installation is below:

- **Naval Station Norfolk** is the world's largest Navy installation, encompassing approximately 4,600 acres. The installation hosts both waterfront and airfield capabilities in support of the Navy's Atlantic Fleet and more than 300 tenant activities. The waterfront serves as the home port for 59 vessels, including aircraft carriers, cruisers, destroyers, and submarines.

8 Sandia National Laboratories. *Development of an Urban Resilience Analysis Framework with Application to Norfolk, Virginia.* SAN D2016-2161, Unlimited Release. March, 2016.

- **Naval Support Activity (NSA) Hampton Roads** is located directly south of Naval Station Norfolk and hosts a large concentration of fleet headquarters administrative and communications functions. The installation includes several discrete areas, totaling approximately 900 acres within the City of Norfolk, and includes Headquarters, Lafayette River Annex, Camp Elmore Marine Corps Base, and South Depot Annex. NSA Hampton Roads originates from the Atlantic Fleet Headquarters Support Activity, established in 1977 to provide administrative, personnel, logistics, maintenance, transportation, special services, supply, and fiscal services to tenant activities and commands so they could operate with maximum emphasis on their primary missions. Several organizational restructuring actions occurred during the 1980s and 1990s, and ultimately the Headquarters Support Activity was disestablished. The installations was renamed "Naval Support Activity Hampton Roads" in 2011.
- **Naval Air Station Oceana** is a master jet base for carrier aircraft and hosts 18 F/A-18 Hornet and Super Hornet squadrons. The main site in the City of Virginia Beach includes more than 5,800 acres, while special area Dam Neck Annex represents an additional 1,800 acres. Special area Naval Auxiliary Landing Field Fentress located in Chesapeake is not included in this study. Air operations at NAS Oceana Main Site exceed 80,000 operations annually.
- **JEB Little Creek-Fort Story** is the result of the consolidation of two formerly discrete military installations, Naval Amphibious Base Little Creek and Army Post Fort Story, in 2009. The installation provides training for U.S. Expeditionary Forces, and covers a land area of approximately 3,300 acres across the two sites. Little Creek hosts waterfront and helicopter operations, and has extensive indoor and outdoor training environments, including large dune and beach areas on the Chesapeake Bay. Fort Story provides additional training capabilities, including beach and offshore areas in the Chesapeake Bay. The JLUS uses JEB Little Creek and JEB Fort Story to differentiate between the two sites.

The purpose of the JLUS is to address a broad range of issues and challenges facing both the Navy installations, and the communities that support them, beyond the "fenceline" of each individual installation. The JLUS aims to establish a better understanding of how conditions on the base and in the community affect each other, and to identify actions that can be pursued jointly to address priority issues and improve quality of life for both military and civilian residents.

1.3.1 ECONOMIC IMPACT OF THE U.S. NAVY IN HAMPTON ROADS

Because of its strategic coastal location along the eastern seaboard, Hampton Roads has been a hub for naval activity for more than 250 years. The Norfolk Naval Shipyard, in Portsmouth, began as Gosport Shipyard in 1767, and is considered the oldest shipyard in the United States.[9] Naval Station Norfolk, located on the site of the 1907 Jamestown Exposition, was established in 1917 and has grown to be known as the largest Navy base in the world. Originally, it was home to the Naval Operating Base and Naval Air Station, collectively referred to as Naval Base Norfolk; in 1999, the Naval Air Station was disestablished, and Chambers Field became part of what is now referred to as Naval Station Norfolk.[10] Today the region's impact extends well beyond the JLUS study area, and protecting and enabling the

9 "Norfolk Naval Shipyard." Virginiaplaces.org. Accessed May 6, 2019. http://www.virginiaplaces.org/military/norfolknavalshipyard.html.
10 "Naval Station Norfolk, Virginia." History.navy.mil. August 30, 2018. https://www.history.navy.mil/browse-by-topic/organization-and-administration/installations/naval-station-norfolk.html.

ability of the Navy to sustain and thrive in Hampton Roads is fundamental to the region's success and a shared goal of the JLUS.

Federal spending is one of the biggest economic drivers in the Hampton Roads region. DoD spending plays a central role in the economy in Hampton Roads, with an enormous impact on jobs and economic growth. According to the HRPDC, based on data collected for the *2018 Hampton Roads Regional Benchmarking Study,* DoD spending on defense contracts in Hampton Roads accounted for between 35 and 40 percent of the region's overall economy (gross domestic product, or GDP) in 2018.[11]

The *Fiscal Year* (FY) *2017 Department of the Navy Economic Impact Report* for the Hampton Roads area, released in November of 2018, estimates the total direct economic impact on the Hampton Roads area from Navy operations in FY2017 at approximately $13.4 billion.[12] This represents an increase of nearly $600 million in direct economic impacts. Annual military, civilian, and contractor payroll associated with Navy operations also increased from FY2016, from $10.6 billion in FY2016 to $11.4 billion in FY2017. The report also shows an increase of more than 5,600 additional active duty military personnel in the region between FY2016 and FY2017, for a total of 87,787 in FY2017. As shown in **Table 1-1,** in FY2017, the JLUS installation with the greatest number of total personnel (including military, civilian, and contractors) was NS Norfolk, followed by JEB Little Creek, then NAS Oceana/Dam Neck Annex, then NSA Hampton Roads. The number of JEB Little Creek-Fort Story personnel grew the most between 2016 and 2017, by 25 percent; conversely, NSA Hampton Roads lost 6 percent of its personnel during the same time period.

TABLE 1-1: FY 2016 & FY 2017 TOTAL PERSONNEL

INSTALLATION	2016	2017	% CHANGE, 2016-2017
Naval Station Norfolk	75,803	76,616	1%
JEB Little Creek - Fort Story	19,788	24,652	25%
NAS Oceana/ Dam Neck Annex	17,366	18,783	8%
NSA Hampton Roads	11,424	10,706	-6%

1.4 JLUS PARTNERS

In addition to the primary project partners, several other entities have contributed to the development of the JLUS, including the Hampton Roads Transportation Planning Organization (HRTPO), the Port of Virginia, the USACE, the U.S. Coast Guard (USCG), and the Hampton Roads Sanitation District (HRSD). These partners play critical roles in contributing to the economic vitality of both cities, protecting and enhancing their physical infrastructure, and safeguarding their residents' health, safety, and welfare. Other state and local agencies, institutions of higher learning, and not-for-profit organizations such as the Hampton Roads Military and Federal Facilities Alliance (HRMFFA), were consulted as part of the stakeholder process and could provide valuable support to Norfolk, Virginia Beach, the Navy, and the HRPDC in implementing projects.

11 Per Whitney Katchmark with HRPDC, April 19, 2019
12 *Fiscal Year (FY) 2017 Department of the Navy Economic Impact Report*. Norfolk, VA: U.S. Navy, November 14, 2017.

Project Leadership and Public Involvement

The JLUS has been overseen by two committees that have each played distinct roles in guiding the process: the Technical Committee helped define the technical focus areas of the study, and the Policy Committee focused on identifying and prioritizing actions. In addition, the process was informed by a robust stakeholder involvement process and input from the public at key milestones.

1.4.1 POLICY COMMITTEE

The role of the JLUS Policy Committee is to oversee the JLUS process, review and validate the work of the Technical Committee, and ensure that the interests of the primary study partners and stakeholders are adequately represented. The voting members of the JLUS Policy Committee include local elected and appointed officials from the cities of Norfolk and Virginia Beach (e.g., mayors, city managers). The non-voting members of the Policy Committee include the HRPDC's Executive Director, senior active duty representatives from Navy Region Mid-Atlantic and the participating installations, and leadership representatives from the USACE.

1.4.2 TECHNICAL COMMITTEE

The primary role of the Technical Committee is to guide the technical analysis, provide supporting information and data, and review and provide comments on materials prepared by the consultant team. The Technical Committee advises the Policy Committee. The Technical Committee includes city department heads and department staff, Community Plans and Liaison Officers (CPLOs) from each Navy installation, and staff from other relevant agencies including USACE, the Virginia Department of Transportation (VDOT), HRSD, Port of VA, and HRTPO. A list of the Technical and Policy Committee members is included in the front cover section of the document.

FIGURE 1-2: Stakeholder Interview Themes

FIGURE 1-3: Steps in the JLUS Planning Process

1.4.3 COMMUNITY PARTICIPATION AND STAKEHOLDER INPUT

Public involvement for the JLUS focused on stakeholder interviews and public meetings at key project milestones. Over 75 stakeholders were interviewed as part of the process, in an effort to document strengths, challenges, and opportunities or desired outcomes of the JLUS. Additional focus group meetings were held with Navy personnel from each installation to define a preliminary list of issues and priorities. A list of interview participants is included in the Appendix.

The interviews were instrumental in providing a comprehensive understanding of challenges from multiple perspectives. The word cloud shown in **Figure 1-2** illustrates the main themes that emerged from the stakeholder interview process. The word size in the diagram reflects how frequently a word or phrase was mentioned. A common theme from stakeholder input was a desire for solutions and priorities that offer regional benefits and imbue collaboration, partnership, and cooperation.

In addition to stakeholder meetings, three public community meetings were held as part of the JLUS public engagement process. **Figure 1-3** identifies the overall planning process and public outreach activities. Over 40 people attended the first public engagement meeting held in May 2018 where residents and stakeholders expressed concerns about frequent flooding in their neighborhoods, more frequent and intense storms, the accelerating pace of SLR in the region, the lack of a comprehensive public transportation network serving both localities, and the need for funding for flood infrastructure projects. ADD INFO ABOUT SECOND MEETING ONCE DETAILS EXIST.

1.5 CURRENT STATE AND FEDERAL INITIATIVES

There are several recent developments at the federal, state, and regional levels that are aimed at addressing resiliency and more specifically flooding and SLR challenges facing local communities and the military. The timing of the JLUS is favorable as it provides the partners an opportunity to leverage these new programs and initiatives and to position the localities to obtain funding to implement JLUS priorities. It could also serve as an example for structuring state and federal assistance programs by showing how communities and military installations can identify shared priorities. These initiatives directly relate to flooding and SLR and are described briefly below.

Defense Access Road Program (DAR) Amendment

The DAR is a cooperative program between the DoD and the Federal Highway Administration (FHWA) that provides a means for the military to pay its share of the cost of public highway improvements necessary to mitigate an unusual impact of a defense activity.[13] The program is jointly administered by the FHWA and

13 "Defense Access Road Program (DAR)." Flh.fhwa.dot.gov. Accessed January 23, 2019. https://flh.fhwa.dot.gov/programs/dar/.

the Military Surface Deployment and Distribution Command. A program amendment to the DAR was included in the 2019 National Defense Authorization Act, allowing funds "to pay the costs of repairing damage caused to, and for any infrastructure to mitigate the risks posed to, highways by recurrent flooding and sea level fluctuation if the Secretary of Defense shall determine that continued access to a military installation has been impacted by past flooding and mean sea level fluctuation."[14]

Defense Community Infrastructure Program

The 2019 National Defense Authorization Act, HR. 5155, Subtitle D, Section 2816, authorizes a defense community infrastructure pilot program that could provide funding to state and local governments to address deficiencies in community infrastructure supportive of a military installation. As of January 2019, funding has not been appropriated for the program. However, this program could potentially provide funding for JLUS actions. The selection of projects eligible for the program would be based upon established criteria, and local governments would be required to provide 30 percent of a project's overall cost. Community infrastructure is defined broadly, and includes any transportation project, school, hospital, police, fire, emergency response, or other community support facility, as well as water, waste water, telecommunications, electric, gas, or other utility infrastructure located off of a military installation and owned by a state or local government.

America's Water Infrastructure Act

The America's Water Infrastructure Act of 2018[15] included authorization for a USACE feasibility study for coastal Virginia to address flood risk management, ecosystem restoration, and navigation. This would likely be implemented through a USACE 3x3x3 study, which lasts no more than three years, has a maximum cost of $3 million, and the vertical team integration happens at three levels of command.[16] The goal of these studies is to derive a recommendation from USACE based on a Benefit-Cost Ratio.[17] The authorization and future studies could directly support the advancement of some of the multi-jurisdictional flood risk management actions and strategies recommended by this JLUS.

Commonwealth of Virginia Executive Order 24

Executive Order (EO) 24 was signed by Governor Ralph Northam on November 2, 2018. The EO identifies a series of actions aimed at increasing resilience to natural hazards and extreme weather statewide. The EO designates the Secretary of Natural Resources as a Chief Resilience Officer and identifies a number of actions to assess the Commonwealth's current resilience status, including the development of a Virginia Coastal Resilience Master Plan and creation of publications and guidance for projecting SLR for local governments.[18] The EO defines a position of Special Assistant to the Governor for Coastal Adaptation and Protection to consult with local governments, relevant state agencies and bodies, regional planning district commissions, and federal partners.

14 National Defense Authorization Act, H.R. 5515 (2019). https://www.congress.gov/115/bills/hr5515/BILLS-115hr5515enr.pdf.
15 America's Water Infrastructure Act, S. 3021 (2018). https://www.congress.gov/115/bills/s3021/BILLS-115s3021enr.pdf
16 Hampton Roads Planning District Commission. "The Summary of the Meeting of the HRPDC Regional Environmental Committee." October 4, 2018. https://www.hrpdcva.gov/uploads/docs/01A_Attachment_October_2018_REC_Summary.pdf.
17 Ibid.
18 Executive Order 24, *Increasing Virginia's Resilience to SLR and Natural Hazards*. November 2, 2018.

Hampton Roads Planning District Commission

In October 2018, the HRPDC adopted a resolution[19] that recommends local governments adopt policies to incorporate SLR into planning and engineering decisions. The resolution recommends using 1.5 feet of relative SLR above current mean higher high water (MHHW) for near-term (2018–2050) planning, 3 feet of relative SLR above current MHHW for mid-term (2050 –2080) planning, and 4.5 feet of relative SLR above current MHHW for long term (2080–2100) planning. These planning thresholds are consistent with those used in this JLUS and are a first step toward integrating SLR projections into local government land use guidance and policies. In addition, the policy also recommends performing individual SLR assessments during project design, which would account for the unique needs and circumstances of specific projects, such as expected lifespan or criticality. The regional policy can also be viewed as an initial step forward in simplifying regional coordination around the issue of SLR and opening the door for more progress toward achieving consistency across multiple jurisdictions.

19 Hampton Roads Planning District Commission 2018-01. *Resolution of the Hampton Roads Planning District Commission Encouraging Local Governments in Hampton Roads to Consider Adopting Policies to Incorporate Sea Level Rise into Planning and Engineering Decisions.* October 18, 2018. https://www.hrpdcva.gov/uploads/docs/HRPDC%20Resolution_Sea%20Level%20Rise%202018-01.pdf.

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2 CHALLENGES AND VULNERABILITIES

The effects of increasing sea level rise and flooding on the natural and built environment in Hampton Roads are of increasing concern to both the localities and the military. Impacts from flooding and future sea level rise could affect the DoD's ability to meet its mission by damaging infrastructure and impeding access to services that the military and community share and jointly rely upon. Increased risks from flooding and sea level rise can result in permanent or temporary damage to infrastructure and buildings, loss or diminished levels of access, and increased costs for repair and rebuilding.

Within the study area, there is a high degree of interdependency between local governments, the Navy, and other providers when it comes to shared resources. Major infrastructure, including roadways and utilities, and essential life safety community facilities and services, such as fire and police, support military readiness and overall community economic viability, health, and safety. In general, the Navy is dependent upon the region's local governments for its roadways, utilities, and many support services.

The stakeholder interview process, focus groups, and public meetings, along with input from the Technical and Policy Committees led to the identification of five core JLUS challenges related to tidal flooding and SLR that influenced the analysis of interdependencies and vulnerabilities. The challenges include:

1. **Getting to work**
   The impacts of tidal flooding caused by high tides on roadways will be exacerbated by additional sea level rise in the future. Even without a storm event, regular tidal flooding on roadways causes road deterioration, slows traffic, and makes certain routes impassable, including those that both Navy personnel and civilians rely upon to get to work. Conditions can result in operational inefficiencies, impact planned operations or security, and result in loss of work time.

2. **Accessing community facilities and services**
   Roadway flooding along key corridors and in neighborhoods limits access to community facilities that military personnel rely upon on a daily basis, such as schools, and could impact emergency services, such as police and fire support. Areas that are not at risk today could be at risk in the future as storm intensities increase and sea levels rise. If a facility is flooded, it can no longer provide a service, and in some cases, other similar facilities or services may not be available nearby or reachable due to flooded roadways.

3. **Managing stormwater**
   Increased levels of precipitation from storm events sometimes overwhelm existing municipal and on-base stormwater management systems, which can result in roadway flooding, safety and access concerns, and issues with water quality and treatment capacity. As sea levels rise, the ability of the existing stormwater management systems to collect, convey, treat, and discharge flow will be further reduced by higher water levels at outfall locations. Improvements to both municipal and on-base stormwater management infrastructure will require collaboration and coordination among multi-jurisdictional partners.

4. **Maintaining utility services**
   Infrastructure utilities such as power, water, and wastewater are critical for maintaining operations on a military base. These networks are provided

by sources outside of the installations. As a result, a comprehensive picture of regional vulnerabilities in the study area is difficult to achieve. However, any disruption to the utility networks or infrastructure elements from current or future flooding could significantly disrupt military operations.

5. **Coordinating between jurisdictions**
   The cities of Virginia Beach and Norfolk have a close working relationship, particularly at the staff level, and both interact regularly with Navy representatives. However, there is a lack of formalized coordination and communication among the three parties. This makes partnering on larger, regional-scale projects and strategies more challenging and makes it more difficult to agree on regional priorities. A formalized mechanism for coordination, particularly about issues related to flooding, sea level rise, and resilience, is needed. Regional coordination challenges are discussed in Chapter 4.

This chapter presents an analysis of these challenges and the potential vulnerabilities associated with flooding and sea level rise on roadways, community services, and utilities through the lens of how the impacts could affect military readiness for the Navy. This analysis utilizes best available data, including geographic information systems (GIS) data provided by the cities of Norfolk and Virginia Beach, the HRPDC, the Navy, and other open source information to define flooding scenarios and perform an analysis of how current and future flooding and sea level rise could affect important roadways, infrastructure, and community facilities. The results of this analysis led to the identification of four primary geographic target areas of concern areas for which specific actions were developed.

2.1 ESTABLISHING JLUS FLOODING SCENARIOS

The first step in identifying and evaluating vulnerabilities to flooding is establishing the flooding scenarios that could be used to evaluate infrastructure and community assets – those elements that the military and community rely upon on a daily basis. The JLUS study area is exposed to three types of flooding that could affect access along strategic corridors used by the military or assets they depend upon: storm surge, tidal flooding, and sea level rise. The scenarios chosen for this JLUS, which are discussed in more detail later in this chapter, are as follows:

1. **Minor tidal flooding with no sea level rise (a peak water level of 1.5 feet above local MHHW)**
2. **1.5 feet of SLR plus minor tidal flooding**
3. **3.0 feet of SLR plus minor tidal flooding**

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides, and is produced by water pushed toward the shore by winds moving cyclonically around the storm.[1] Storm surge is considered a shock, or sudden event, and can have catastrophic impacts on life and property, as evidenced by recent storms such as Hurricane Matthew and Hurricane Florence. While this type of event and resultant flooding is a serious concern, per the direction of the Technical Committee, the JLUS is focused on addressing the chronic flooding issues that affect daily routines, such as tidal or nuisance flooding, and which are expected to increase over time in the region as sea level rises. Also known as "nuisance flooding," such chronic tidal flooding is already a common occurrence in the study area that affects access to Navy installations and community assets.

1 "Storm Surge Overview." Nhc.noaa.gov. Accessed January 18, 2019..https://www.nhc.noaa.gov/surge/

Chronic flooding can also be triggered by rainfall events, and guidance from the National Climate Assessments and other sources indicates that the region can expect more frequent and intense rainfall events in the future. The level of data needed to quantitatively evaluate frequency and depth of rainfall-induced flooding for the JLUS is not yet consistently available across the study area. Both cities and the Navy are working through evaluations of their stormwater management systems, so that this type of data will be more available in the future, and this will benefit implementation of JLUS recommendations. The JLUS incorporated rainfall-related flooding qualitatively by utilizing historical street and property flooding observations, collected by city staff and reported by residents over several years, to identify areas that repeatedly flood during intense rainfall events (with and without high tide conditions). JLUS recommendations include considerations of solutions that mitigate both tidal flooding and rainfall-induced flooding.

To understand how tidal cycles can cause nuisance flooding and/or worsen the effects of rainfall or storm surge flooding in the study area, historical water level observations at a number of tide gauge stations maintained by the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) were reviewed. For the purposes of this study, a minor tidal flooding event (also referred to as a "nuisance flooding") is defined as a peak water level of 1.5 feet above local Mean Higher High Water (MHHW). This definition is based on the range generally used in public notices to warn residents of minor tidal flooding events in the study area.

Various climate models have produced different sea level rise "curves" and projections for the future, depending on the data, methodology, and time frame being used, as shown in **Figure 2-1**. Multiple sources of sea level rise projections were evaluated as part of the analysis, including data from the DoD, NOAA, the USACE, and the Virginia Institute of Marine Science (VIMS). The projections evaluated indicate that sea level rise in the next 20 years could range between 0.5 foot and 1.5 feet and in 50 years could range between 1 foot and 3.8 feet. While the absolute values of estimated sea level rise differ by source, the values do not differ significantly from each other along a similarly named curve at a similar point in time. Sea level rise estimates from the DoD's Coastal Assessment Regional Scenario Working Group (CARSWG) generally agree with estimates from NOAA, USACE, and VIMS in the study time frame, but diverge somewhat as the timeline moves closer to 2100. The four sources used in determining sea level rise projections are described below.

Mean Higher High Water (MHHW) – The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. (Source: NOAA Tidal Datums)

1. **DoD Coastal Assessment Regional Scenario Working Group (CARSWG).** The CARSWG database contains sea level rise projections made by the Strategic Environmental Research and Development Program (SERDP), an inter-agency working group including the DoD, Environmental Protection Agency (EPA) and Department of Energy. The SERDP sea level rise projections[2] make site-specific adjustments to mean sea level change scenarios from the U.S. Third National Climate Assessment (Parris et al., 2013), including regional adjustments such as ice melt and dynamical sea level effects in the local projections.
2. **NOAA.** Projections at NOAA tide stations utilize data and methods from the Third National Climate Assessment along with vertical land movement associated with the specific NOAA tide station.

2 Hall et al. *2016. Regional Sea Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide.* U.S. Department of Defense, Strategic Environmental Research and Development Program. 224 pp.

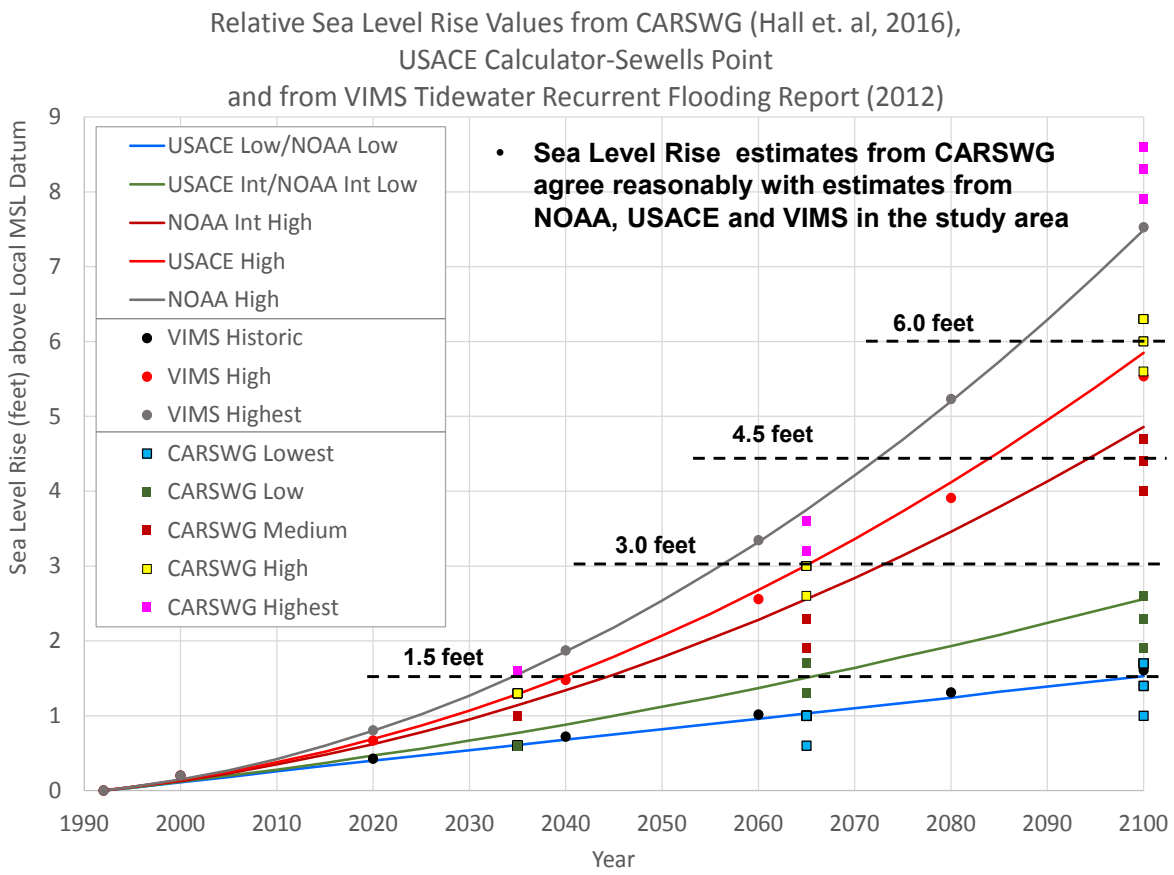


FIGURE 2-1: Sea Level Rise Curves

NOAA sea level rise projections were accessed via the USACE's online sea level change calculator.

3. **USACE.** Projections at NOAA tide stations utilize historical sea level change rates (from tide gauge observations) along with projections by the National Research Council. The USACE projections, at the time the data were accessed for this study, do not include regional effects of ice melt and dynamical sea level.

4. **VIMS, as published in the Recurrent Flooding Study for Tidewater Virginia.**[3] The VIMS projections are focused on Tidewater Virginia and utilize Tidewater area vertical land movements. Like the NOAA and SERDP projections, the VIMS study utilized the Third National Climate Assessment, including regional effects of ice melt and dynamical sea level. The VIMS report relied on a technical report prepared as part of the Third National Climate Assessment, which was in progress during the timeline of the VIMS report.[4]

The Technical Committee provided feedback on acceptable sea level rise ranges for the JLUS planning horizon, roughly 2020 to 2065, or about a 45-year span. Within this time frame, the projections show a range of 0.5 foot to 4.0 feet of sea level rise. The Technical Committee agreed on a range of 1.5

3 Mitchell et al. *Recurrent Flooding Study for Tidewater Virginia.* Virginia Institute of Marine Science, January 2013.
4 U.S. Global Change Research Program. *Third National Climate Assessment.* Globalchange.gov. May 2014. https://nca2014.globalchange.gov/downloads.

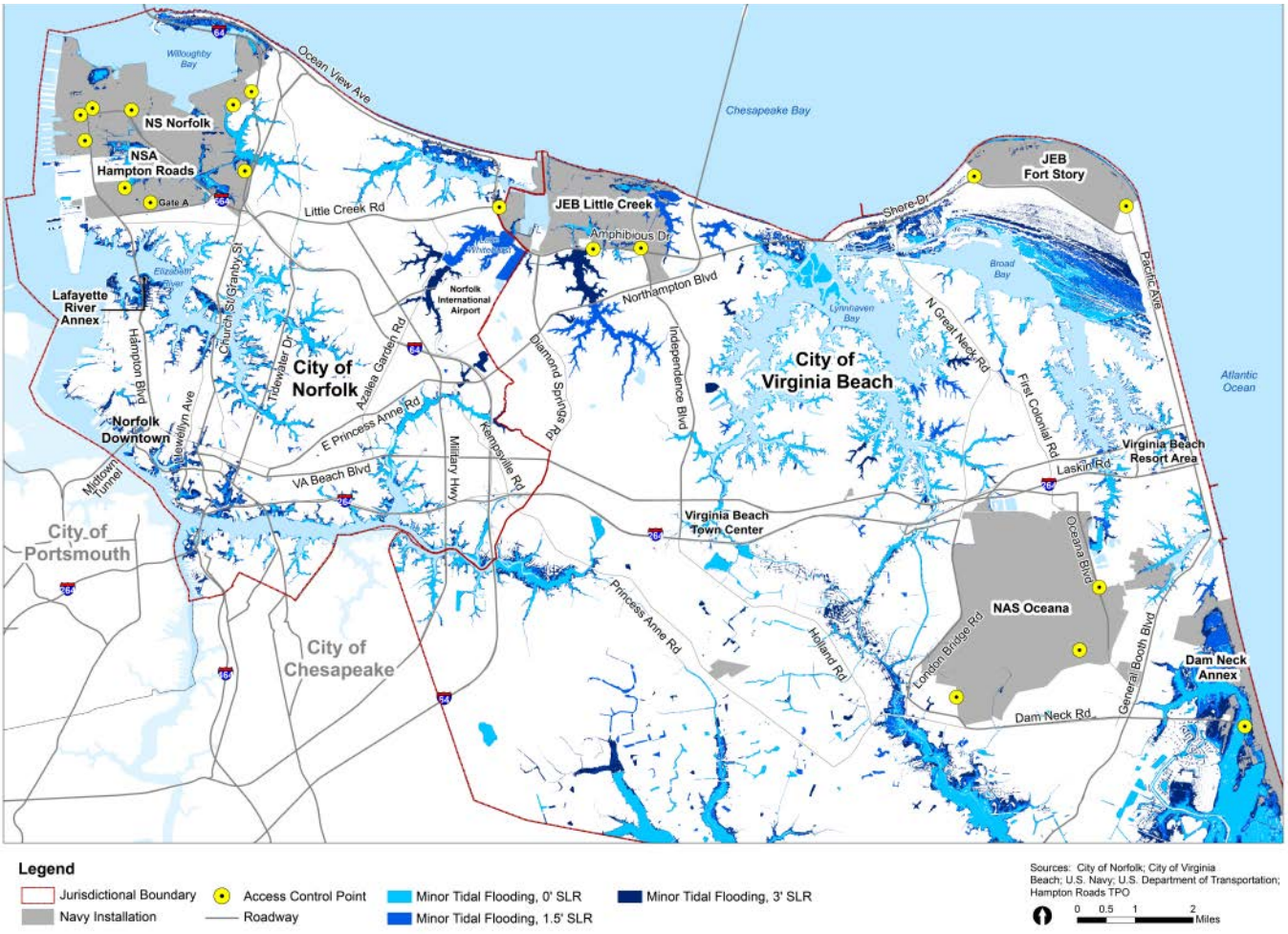


FIGURE 2-2: Sea Level Rise Scenarios

feet to 3.0 feet of sea level rise as the planning parameters to be used for analysis, which approximately captures the range of most of the projections by year 2067. This range also aligns with estimates currently in use by Norfolk and Virginia Beach in their ongoing planning and policy initiatives. The following flooding scenarios, shown on the map in **Figure 2-2**, served as the basis for the vulnerability analyses conducted as part of the JLUS:

1. **Minor tidal flooding with no sea level rise (a peak water level of 1.5 feet above local MHHW)**
2. **1.5 feet of SLR plus minor tidal flooding**
3. **3.0 feet of SLR plus minor tidal flooding**

Defining the appropriate datasets to use for characterizing tidal water levels and sea level change across the project area was a critical first step in the vulnerability assessment process. Once selected, these datasets, along with other inputs, were used to evaluate how community assets, transportation infrastructure, and services could be impacted under different sea level rise and flooding scenarios, including associated impacts on access.

2.2 ACCESS TO DOD INSTALLATIONS – GETTING TO WORK

According to the HRTPO's 2018 *State of Transportation in Hampton Roads* report, VDOT estimates that there were nearly 41 million vehicle-miles of travel (VMT) on a typical day in Hampton Roads in 2017, and that VMT has been increasing slowly but steadily since 2008.[5] The regional roadway network is an imperative asset for all people who live and work throughout the region. It enables access to strategic military installations and facilitates the movement of people, goods, and services that fuel the local and regional economy.

Impacts to the network due to flooding and sea level rise could reduce or eliminate access in some areas and lead to impacts on military personnel and mission readiness. According to the FY17 *Navy Region Mid Atlantic Economic Impact Report*, over 130,000 military personnel, civilian employees, and contractors work on NS Norfolk, JEB Little Creek, JEB Fort Story, NAS Oceana, and NSA Hampton Roads. Understanding potential vulnerabilities of the regional transportation network to the Navy workforce is the first step to ensuring reliable access for the Navy.

Roadways Serving the Military

Based on data in the HRTPO's 2013 *Military Transportation Needs Study* and direct input from the Navy regarding travel patterns, over 200 miles of regional and local roadways were identified as either primary or secondary corridors serving the Navy, as shown in **Figure 2-3**. The network includes the Strategic Highway Network (STRAHNET) for the DoD, defined as the "minimum public highway infrastructure…needed to fulfill [the military's] mission and to ensure defense readiness capability,"[6] as well as other roads identified by the HRTPO and military stakeholders as important. All major roadways considered significant to supporting the military mission, along with major roadways that provide direct access to installation entry control points, were classified as "primary." Impacts to primary roadways due to flooding are assumed to have a higher level of impact on military readiness. Roadways that directly serve an installation but were not considered to be major roadways were classified as "secondary."

To further inform the transportation analysis, the Navy provided home-based zip code data for personnel working at the installations in Norfolk and Virginia Beach. Understanding where personnel live and work is an important component of determining how roadway network vulnerabilities to flooding and sea level rise could impact mission and personnel readiness. The zip codes that surround JEB Little Creek, NS Norfolk, and NSA Hampton Roads have some of the highest concentrations of Navy personnel in Hampton Roads according to the data. Several major corridors serving the DoD directly serve these areas, including Hampton Boulevard and Shore Drive. These are also roadways that are highly vulnerable to both high levels of traffic congestion and recurrent flooding, as well as projected impacts from rising sea levels.

Primary roadways that link higher concentrations of Navy commuters directly to an installation are more likely to experience regular congestion, particularly at peak travel times associated with Navy work shifts. If these routes are congested, flooded, or otherwise impeded, mission readiness could be affected. These transportation issues also impact quality-of-life for both military personnel (and their dependents) and non-military residents throughout Hampton Roads.

5 *The State of Transportation in Hampton Roads 2018.* Hampton Roads Transportation Planning Organization. October 2018. https://www.hrtpo.org/uploads/docs/100318%2015%20Enclosure%20State%20of%20Transportation%202018%20-%20Final%20Report.pdf.

6 *Hampton Roads Military Transportation Needs Study.* Hampton Roads Transportation Planning Organization. July 2013. https://www.hrtpo.org/uploads/docs/Roadways%20Serving%20the%20Military%20&%20Sea%20Level%20Rise-Storm%20Surge%20Report.pdf.

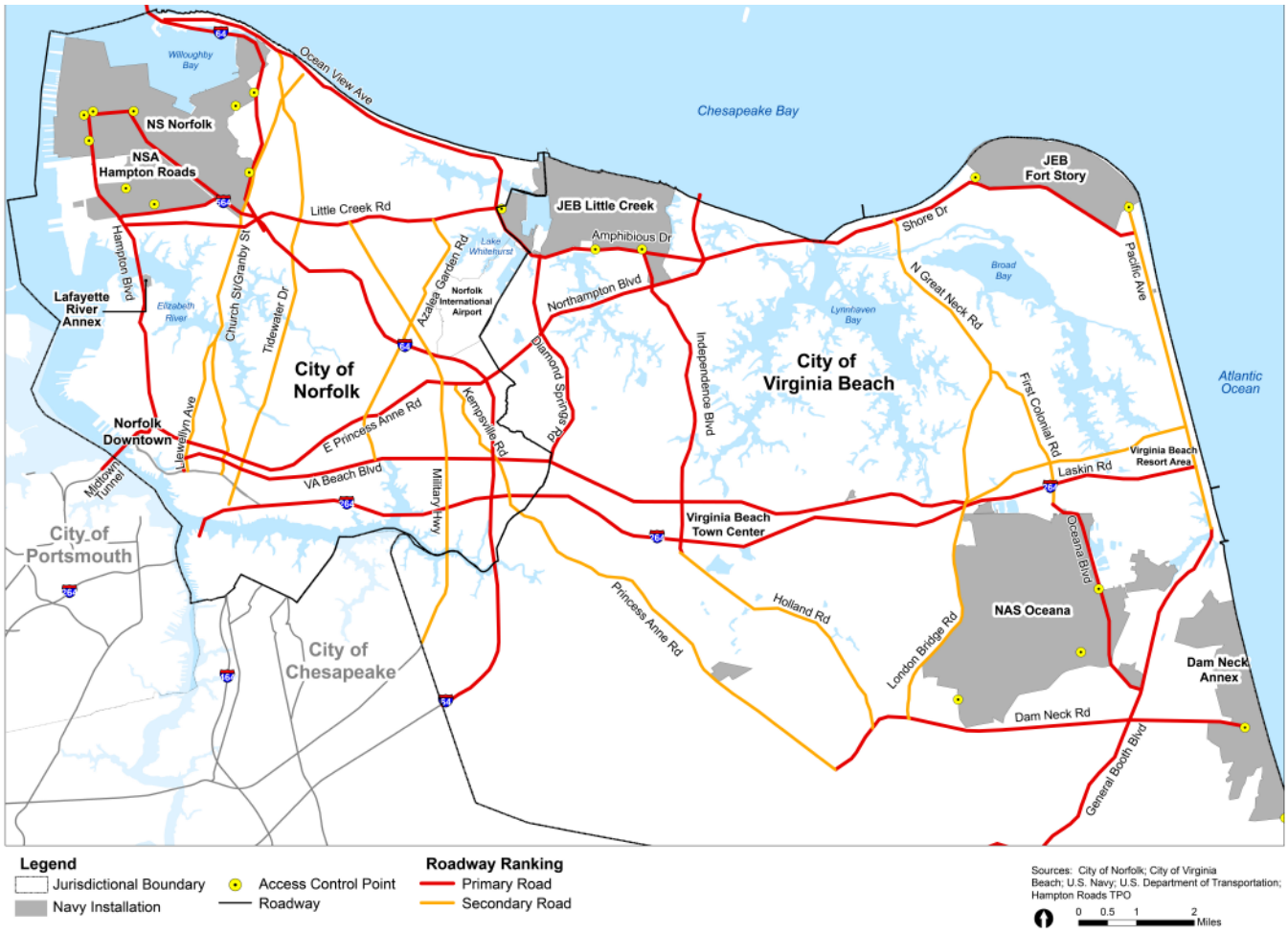


FIGURE 2-3: Roadways Serving the DoD

Not only is it difficult for both military and non-military residents to get to and from work, but roadway congestion and flooding can interfere with their ability to drop their children off at school or daycare, run errands, visit the doctor, and generally go about the business of daily life. With rising sea levels and increases in frequency and levels of roadway flooding, along with worsening congestion as the region's population grows, current transportation nuisances could become more serious problems in the future.

While alternative transportation options in the study area exist, Hampton Roads Transit (HRT) bus service relies upon the same roadways as personal vehicles and would be subject to the same flood risk.

Generally, bus service and vanpooling options are not widely used by the military. In some areas, there are nearby trails or bike lanes that could provide an alternate option for getting to an installation, but direct trail access is not widespread. However, Norfolk is working to extend the Elizabeth River Trail along Hampton Boulevard to NS Norfolk. The Navy, specifically NS Norfolk, has expressed interest in and support for the extension of light rail to the installation. HRT is planning on studying potential alignments for expanded service in the near future, but does not have any active light rail extension studies at this time. The HRT FY2018–2027 *Transit Development Plan* proposes multiple bus route

improvements/changes for both Norfolk and Virginia Beach, including increasing bus frequency on popular routes, which HRT anticipates will increase ridership by 18 percent in Norfolk and 31 percent in Virginia Beach.[7] Increased transit options could help sailors that do not own vehicles access more community amenities, and could potentially reduce parking pressures at the installations. To be a preferred option for commuters, a parallel and convenient on-base circulation system would need to be developed and implemented by the Navy.

Transportation Vulnerability Assessment

In order to better understand how roadway flooding could affect the primary and secondary corridors serving the military,[8] a vulnerability assessment was performed using GIS software, digital elevation data,[9] and the three sea level rise scenarios defined for this JLUS. Exposure to flooding was based on the depth of water estimated to occur at the lowest elevation grade along each roadway segment of approximately 100 feet in length. The analysis focused on those

7 *Transit Development Plan FY2018–2027.* Hampton Roads Transit, January 2018. https://gohrt.com/wp-content/uploads/2018/07/Transit-Development-Plan-2018-2027.pdf.
8 Hampton Roads Planning District Commission LiDAR Digital Elevation Model, 2013
9 Regional roadway dataset used for analysis provided by HRTPO in 2017

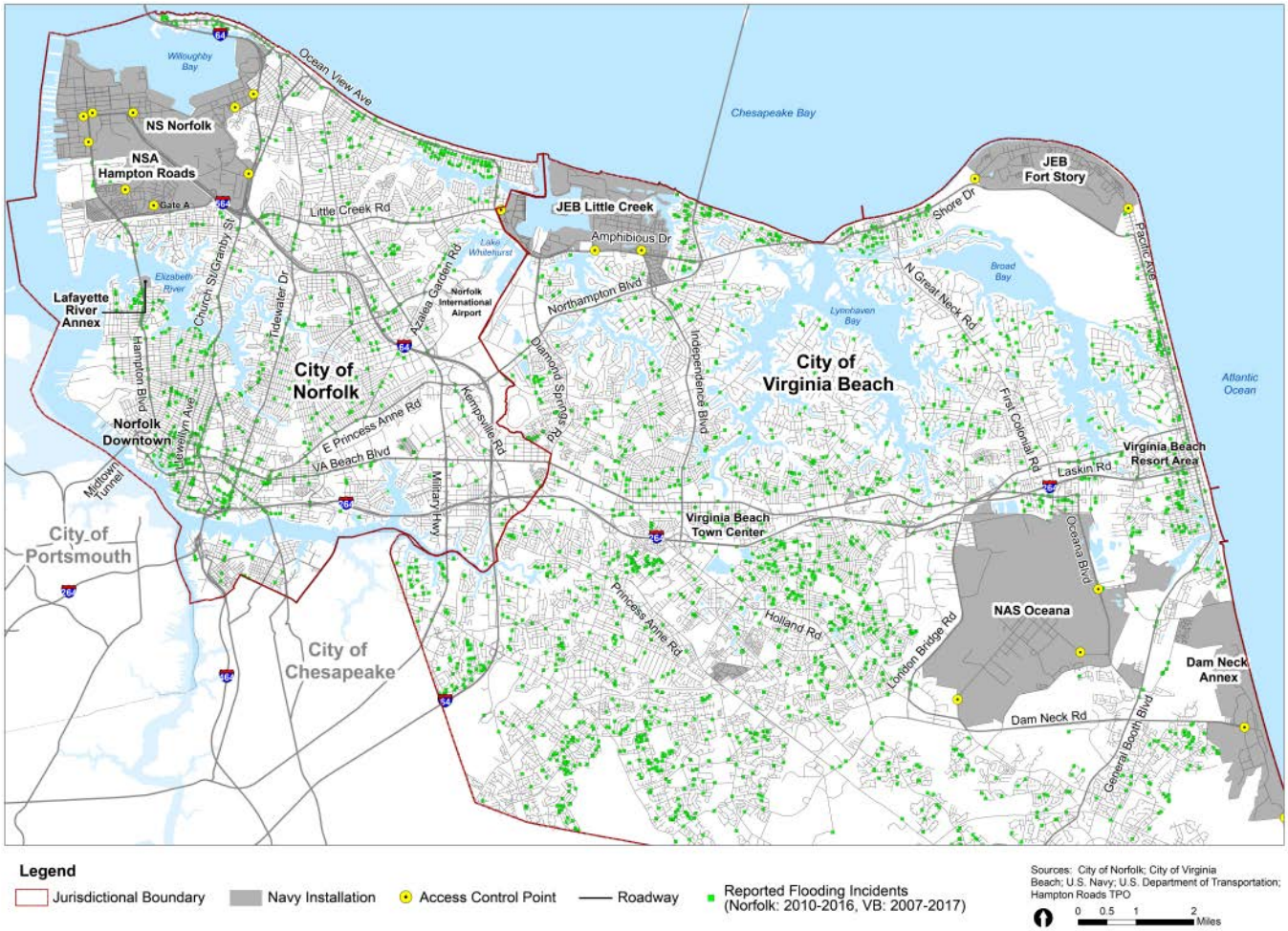


FIGURE 2-4: Historical Flooding Complaints

roadways most directly serving the military installations in the study area, but also evaluated adjacent local roads and connector streets to better understand interconnections between critical routes. Roadways internal to the Navy installations were not included in the analysis and existing flood mitigation measures, such as the floodwall in downtown Norfolk, were not taken into account.

The analysis only considers flooding due to tidal sources, including high tides, minor tidal flooding, and sea level rise. Vulnerability to stormwater flooding caused by precipitation and/or stormwater management infrastructure issues was not directly evaluated due to insufficient and inconsistent data across the study area. Historical flooding complaint data from the cities shown in **Figure 2-4** identifies the locations where residents have reported recurrent flooding during and after various storm events, and helps to indicate where stormwater flooding is an issue. The miles of roadway that would be potentially impacted by flooding under each sea level rise scenario are shown below and in **Figure 2-5**:

- Minor tidal flooding, 0.0 feet of SLR: 35 miles
- 1.5 feet of SLR plus minor tidal flooding: 104 miles
- 3.0 feet of SLR plus minor tidal flooding: 269 miles

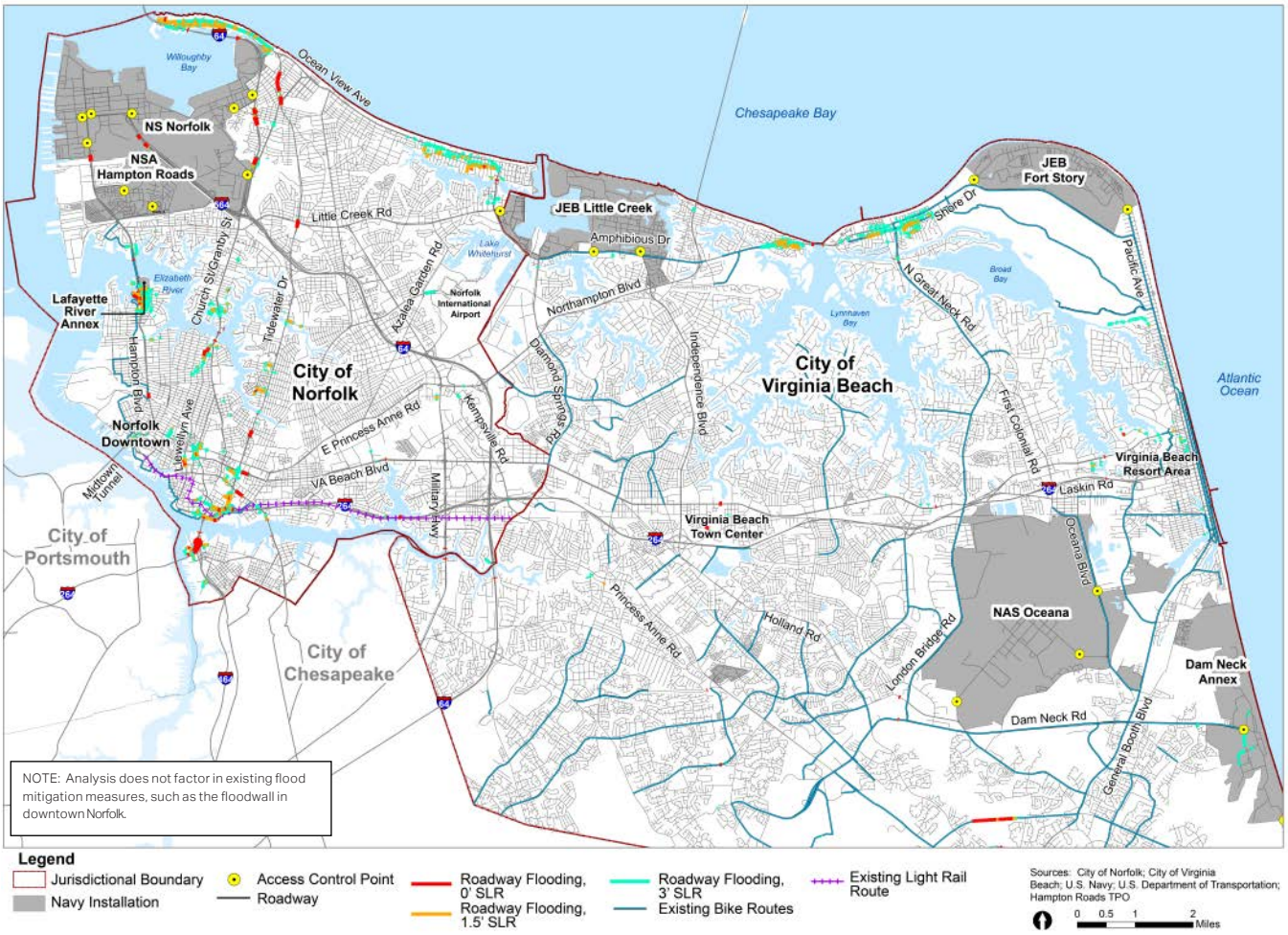


FIGURE 2-5: Transportation Vulnerability Analysis

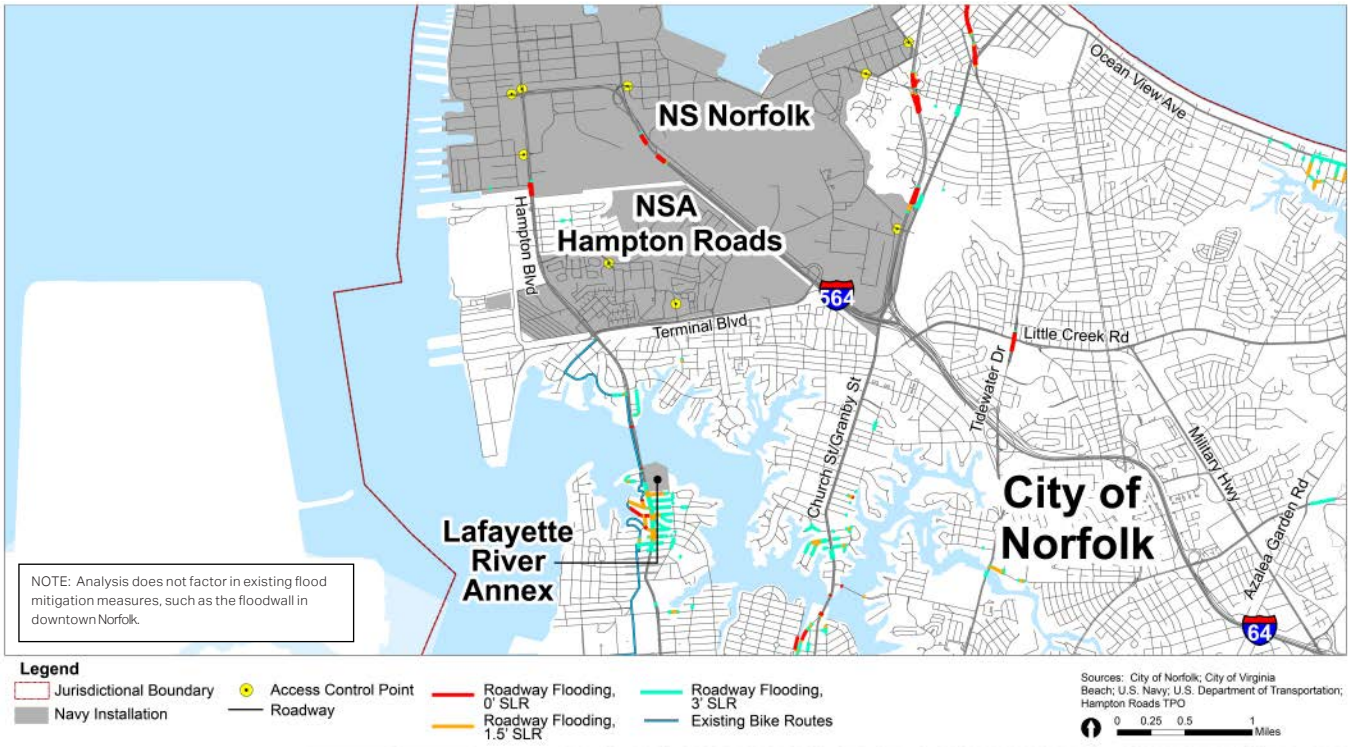


FIGURE 2-6: Hampton Boulevard Transportation Vulnerability Analysis

Several roadways identified as "problem areas" already experiencing minor tidal flooding are captured through this analysis. More importantly, several roadways exposed to flooding were identified as primary or secondary roadways serving the military or are routes that connect directly to these roadways.

Key corridors that are currently most vulnerable to roadway flooding include sections of Hampton Boulevard, Shore Drive, and Sandbridge Road, as shown in **Figures 2-6, 2-7,** and **2-8**. Hampton Boulevard is a primary north-south corridor that directly serves NS Norfolk, NSA Hampton Roads, and Lafayette River Annex. It is a heavily traveled corridor and also provides critical access to Norfolk International Terminals (NIT). Sections of the corridor are already impacted by flooding today and conditions will worsen over time, especially just north and south of the Lafayette River, potentially making the corridor impassable. Without intervention, the Lafayette River Annex site could be inaccessible at 3.0 feet of sea level rise.

Shore Drive is a primary east-west corridor that directly serves JEB Little Creek and JEB Fort Story. Shore Drive, both east and west of the bridge over Pretty Lake (adjacent to Little Creek Inlet), is likely to become more susceptible to flooding with additional sea level rise. Flooding along this corridor would directly limit access to both JEB Little Creek-Fort Story properties, and could affect the entry control point near Little Creek Road. Likewise, potential flooding impacts from both rainfall and tidal flooding could be expected along segments of Shore Drive

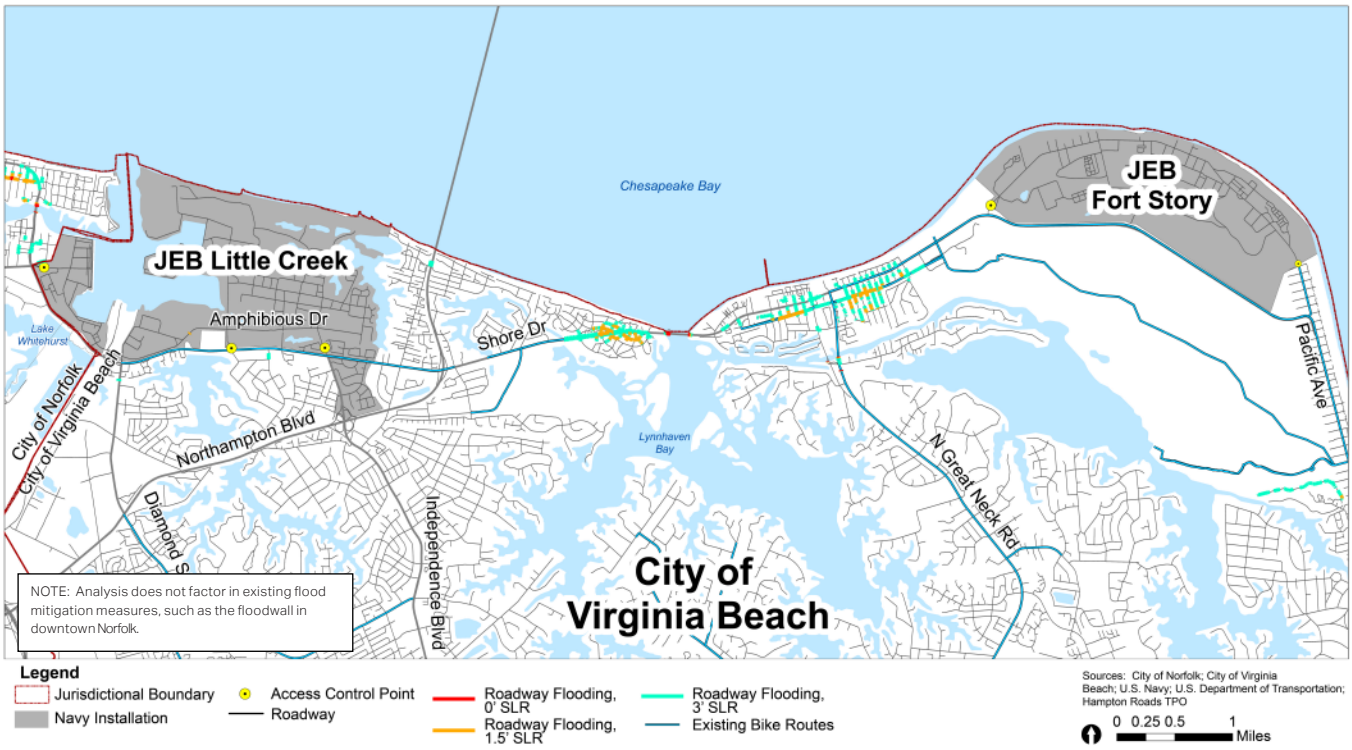


FIGURE 2-7: Shore Drive Transportation Vulnerability Analysis

near the Lesner Bridge, which crosses the Lynnhaven Inlet and is the only access route to JEB Fort Story in this area. According to the preliminary findings from the Virginia Beach *Comprehensive Sea Level Rise and Flooding Study,* the beachfront area both east and west of the Lynnhaven Inlet will become increasingly vulnerable to flooding impacts as sea levels rise. In a presentation on the study's progress, made to Virginia Beach's City Council in January 2019, a system of floodwalls, dunes, and tide gates to mitigate flood risk both east and west of the Lesner Bridge is presented as a possible solution.[10] If Shore Drive is blocked, JEB Fort Story access would be reduced to one entry control point off of Atlantic Avenue, which would require eastbound traffic to take a significant detour to the south (the distance of the detour would depend on the portion of Shore Drive that is inaccessible).

Sandbridge Road provides the only access to and from the Sandbridge community in southern Virginia Beach, which is bordered by the Atlantic Ocean on the east and the Back Bay on the west. It is currently affected by tidal flooding and sometimes floods during heavy rainfall events that cause closure of the road. When this occurs, public traffic is re-routed through the South Gate entry control point at Dam Neck Annex since there is no alternative route. Virginia Beach and the base work closely to coordinate and manage access during these events; however, it does create security challenges for the

10 City of Virginia Beach, "Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Planning Study: Policy Recommendations and City-wide Flood Protection Strategies." Presentation, Virginia Beach, VA, January 15, 2019. https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/slr-rf-plan-study-policy-strat-council-brief-1-15-19.pdf.

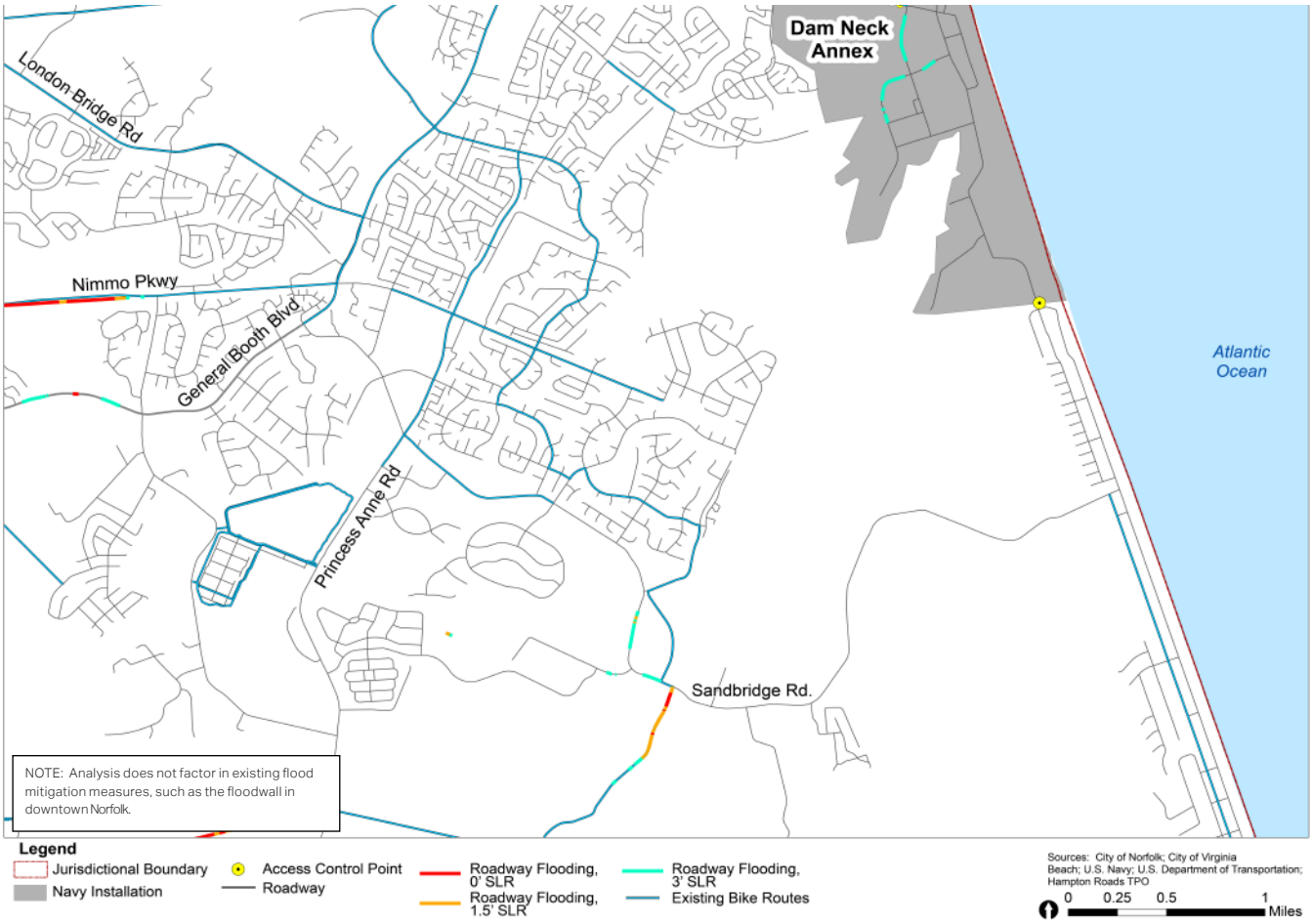


FIGURE 2-8: Sandbridge Road Transportation Vulnerability Analysis

base related to force protection. Virginia Beach is extending Nimmo Parkway to connect to the Sandbridge community, which would alleviate concerns about relying on Sandbridge Road as the primary route for this community. Phase VII-A of the project, which stretches from Sandpiper Road to Atwoodtown Road, will raise the roadway elevation to be passable during a 100-year flood, and accounts for 3 additional feet of sea level rise above current levels.[11]

Flooding along primary routes used by the military, particularly Hampton Boulevard, Shore Drive, and Sandbridge Road, will directly impact access to NS Norfolk, NSA Hampton Roads, the Lafayette River Annex, both JEB Little Creek and JEB Fort Story, and Dam Neck Annex. All three of these roads already experience some level of flooding due to either storm events or tidal conditions. Furthermore, high levels of congestion along these corridors will place added pressure on the overall transportation network.

11 "2.078.000: Sandbridge Road-Nimmo Phase VII-A." Cipstatus.vbgov.com. Last modified April 9, 2019. http://cipstatus.vbgov.com/ProjectDetail.aspx?id=1602.

Corridors like Hampton Boulevard and Shore Drive are already moderately to severely congested leading up to some entry control points. Adding sea level rise will exacerbate access conditions and will have a direct impact on military readiness.

Several major regional transportation projects outlined in the HRTPO's *2040 Long-Range Transportation Plan* are designed to alleviate traffic congestion and improve mobility throughout the region. For instance, the I-564 Intermodal Connector will alleviate truck traffic on Hampton Boulevard and provide more direct access to Naval Station Norfolk's Gate 6.[12] However, these projects do not directly address congestion caused by flooding.

2.3 ACCESS TO COMMUNITY ASSETS

The sea level rise scenarios defined for the JLUS identify areas in both cities that will experience increased stress from flooding over time. The land use and development patterns and population density in both cities are factors that have a direct relationship with the potential degree of impact on life and property that the area could experience from sea level rise over time. Locations where the population is expected to grow significantly, and where flooding and access issues are expected to worsen as sea levels continue to rise, are areas of particular concern. For the population living in these areas, living their day-to-day lives could become increasingly challenging due to flooded roadways, which impede access to homes, jobs, and community services, and exacerbate traffic congestion.

Population Growth Patterns

Both Norfolk and Virginia Beach have experienced steady population growth since 2000, although Norfolk has grown at a slower rate overall than Virginia Beach.[13] Population projections from the University of Virginia's Weldon Cooper Center project that Norfolk and Virginia Beach will continue to experience modest levels of population growth in the coming years, but at a lower rate than the overall Hampton Roads region, and the Commonwealth of Virginia as a whole.[14] *The Hampton Roads 2045 Socioeconomic Forecast and Transportation Analysis Zone* (TAZ) *Allocation Report*, a long-range socioeconomic forecast used to inform the region's travel demand model, forecasts that out of the 16 localities that make up the Hampton Roads area, Virginia Beach ranks seventh in terms of growth rate. The report projects that Norfolk's population will grow at a slower rate than Virginia Beach, ranking 11th out of 16. In raw numbers, Virginia Beach is expected to grow by approximately 14 percent, adding more than 65,000 people between now and the year 2045, and Norfolk is expected to grow by approximately 7 percent, gaining nearly 17,000 residents during the same time period.[15] These time periods roughly correlate to the time period under which 1.5 feet of sea level rise could occur. At the TAZ level, the areas projected to have the greatest percentage increase in population are located on or near NAS Oceana and Dam Neck Annex; near downtown Norfolk and Virginia Beach Town Center; and near Virginia Beach's resort area. Downtown Norfolk and Virginia Beach's resort area are designated by the localities as growth areas, which are intended to accommodate higher-density, mixed use growth patterns. **Figure 2-9** displays

12 *2040 Long-Range Transportation Plan.* Hampton Roads Transportation Planning Organization, July 2016.
13 Houp, Will. "Virginia's population is growing at its slowest rate in nearly 100 years." *The Virginian Pilot,* February 14, 2017. https://pilotonline.com/news/local/virginia-s-population-is-growing-at-its-slowest-rate-in/article_8e17f21e-2180-5c14-beae-80ce3a8b97c9.html.
14 Projections from the Weldon Cooper Center of the University of Virginia, March 2017
15 *Hampton Roads 2045 Socioeconomic Forecast and TAZ Allocation Report*. Hampton Roads Transportation Planning Organization, February 2019.

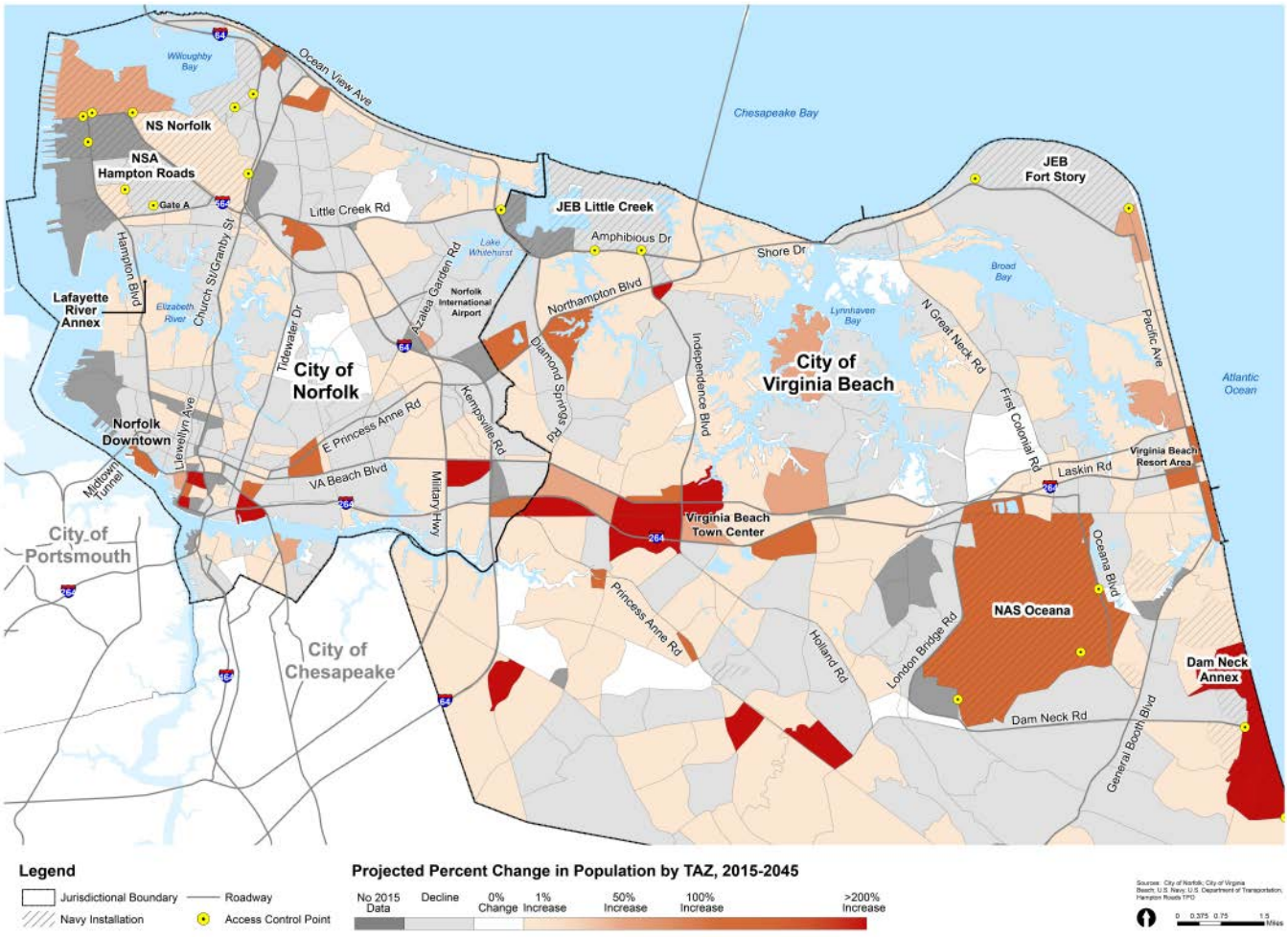


FIGURE 2-9: Projected Percent Change in Population by Transportation Analysis Zone, 2015–2045

population projections for the study area by TAZ.[16] The TAZ projections also estimate that both Norfolk and Virginia Beach will experience modest job growth between 2015 and 2045. Virginia Beach is expected to just over 16,000 jobs between 2015 and 2045, an increase of about 6 percent, and Norfolk is expected to add more than 4,000 jobs within the same time period, an increase of about 2 percent. As **Figure 2-10** shows, employment is expected to grow significantly at NSA Hampton Roads and in several zones near NS Norfolk, as well as near Lambert's Point and in parts of the downtown Norfolk and Berkley areas.[17] The TAZ dataset projects significant employment growth in Virginia Beach's resort area and in the zone just north of Dam Neck Annex, as well as near Town Center and in several zones near the Lynnhaven Bay and Shore Drive on the north side of the City.

16 Per HRTPO staff, determinations for how projected population and employment growth is apportioned by TAZ are made separately by each locality.
17 Ibid

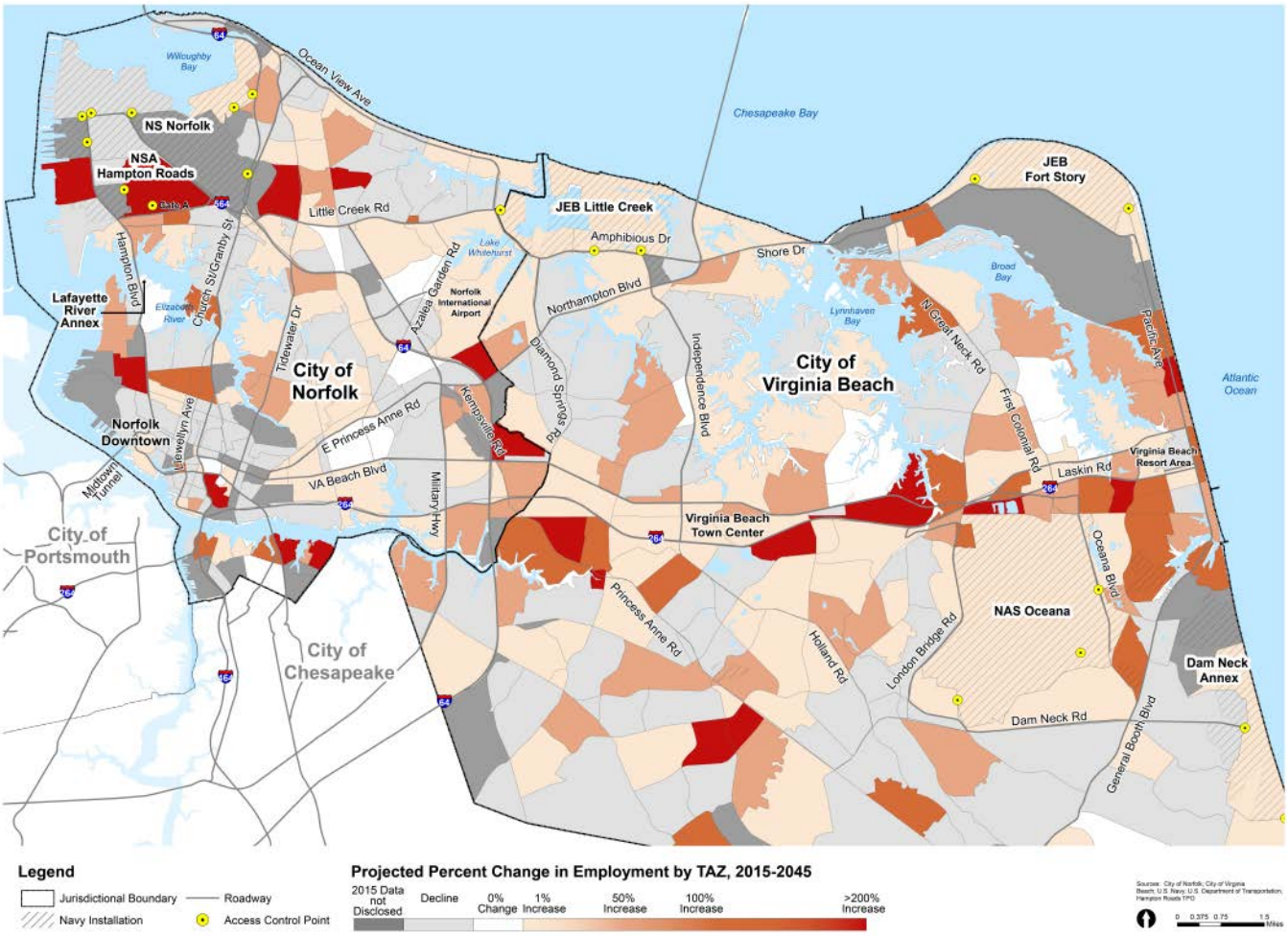


FIGURE 2-10: Projected Percent Change in Employment by Transportation Analysis Zone, 2015–2045

Community Assets Vulnerability Assessment

Current and future residents will require multiple community assets and services for their education, health, safety, and general welfare. To understand how certain community assets could be affected by flooding and sea level rise, an analysis was undertaken to determine the potential exposure of assets to flooding. The first step in this analysis was to identify assets of importance. For the purposes of the JLUS, community assets are broadly defined to include both life-safety and transportation elements that provide a value or benefit to the Navy installations, military service members and their families, as well as the broader community. The definition of community assets was informed by the *2017 Hampton Roads Hazard Mitigation Plan* and the *USACE Integrated City of Norfolk Coastal Storm Risk Management (CSRM) Feasibility Study/Environmental*

Impact Statement (2018).[18] The asset types included in the exposure analysis were identified as having a relationship to military personnel readiness. For example, impacts to schools, hospitals, or emergency services could all lead to lost work time for military personnel. Assets considered in the exposure analysis include:

- Hospitals
- Fire and emergency medical services (EMS) stations
- Police stations
- Schools
- Emergency shelters
- Emergency operations centers
- Electric substations
- Water and sanitary pump stations
- Water and wastewater treatment plants

Over 1,200 community assets were identified across Norfolk and Virginia Beach[19] and were analyzed to determine their exposure to tidal flooding and future sea level rise[20] based on the depth of water at the lowest adjacent elevation grade to the building.[21] If building footprints were not available, values from both the HRPDC digital elevation model (DEM) and MHHW elevation grids were assigned to each of the features. As with the Transportation Vulnerability Analysis, this analysis does not take existing flood mitigation measures, such as the floodwall in downtown Norfolk, into account, and does not include on-base assets.

Based on these parameters (and excluding the AE/VE zones),[22] a total of 123 assets could be affected in one or more of the scenarios, as shown in **Table 2-1** and organized by category in **Figure 2-11.**[23]

Sanitary pump stations account for the largest percentage of affected assets (83 percent), followed by schools (7 percent). Seven sanitary pump stations facilities are currently located in the VE Zone. While a few electric substations, fire stations, and shelters (including 14 schools that also serve as emergency shelters) are identified as being in the AE or VE Zone, relatively few of these features have adjacent grade elevations low enough to be directly affected by minor tidal flooding at the present and future sea level rise scenarios being evaluated.

Excluding sanitary pump stations and water pump stations, 20 community assets in Norfolk and Virginia Beach are exposed to minor tidal flooding with 3.0 feet of sea level rise; five are exposed at 1.5 feet of sea level rise. Two wastewater treatment plants (WWTPs) are currently considered vulnerable to minor tidal flooding under the analysis.

18 The *Hampton Roads Hazard Mitigation Plan* identifies essential facilities and infrastructure as "those facilities or systems whose incapacity or destruction would present an immediate threat to life, public health, and safety or have a debilitating effect on the economic security of the region.." The *USACE Integrated City of Norfolk Coastal Storm Risk Management (CSRM) Feasibility Study/Environmental Impact Statement* identifies and evaluates important resources that could be impacted, including utilities, transportation, socioeconomic, cultural, and natural/environmental resources.

19 Navy installation assets were not evaluated as part of the asset analysis; however, access to each Navy installation was factored into the overall network accessibility analysis.

20 The analysis does not incorporate precipitation flooding, due to the lack of availability of a comprehensive technical dataset for both localities at this time.

21 As estimated from the HRPDC LiDAR -based DEM and the MHHW elevation grids.

22 Number and type of community assets impacted is based on community asset GIS data provided by Norfolk and Virginia Beach in March 2017. A regional dataset provided by HRSD in Marcy 2019 was used determine sanitary pump station ownership of those pump stations included in the city-provided data. Discrepancies between city and regional data for pump stations exist, but were not resolved as part of the JLUS study.

23 Although this analysis does not examine the impact of storm events on these assets, understanding which FEMA zone the assets fall within is important supplemental information for making decisions on a local level regarding how to address vulnerable assets. An asset was identified as being in the floodplain if the building footprint or the point feature was located within 20 feet of the AE or VE Zone boundaries in the Flood Insurance Rate Map (FIRM) GIS layers. The 20-foot buffer was applied to account for some uncertainty in determining the exact location of some of the community asset features at this planning level. Assets may therefore be in an AE, VE or V zone but outside the scenarios evaluated as part of this analysis.

TABLE 2-1: COMMUNITY ASSET EXPOSURE

FACILITY	CITY	EXPOSURE			IN AE OR VE ZONE	IN VE ZONE
		0′ SLR	1.5′ SLR	3.0′ SLR		
Hospitals		0	0	1	1	0
Norfolk Sentara	Norfolk	no	no	yes		
Fire/EMS		0	0	2	4	0
Station #6	Norfolk	no	no	yes		
Fire 01/EMS 22 - First Landing	Virginia Beach	no	no	yes		
Police Stations		0	0	1	0	0
Fire and Police Administration	Norfolk	no	no	yes		
Schools		0	2	8	14	0
Willoughby Elementary	Norfolk	no	no	yes		
Tidewater Park Elementary	Norfolk	no	yes	yes		
St. Patrick's Catholic School	Norfolk	no	no	yes		
Ghent Montessori School	Norfolk	no	no	yes		
Ruffner Academy	Norfolk	no	no	yes		
Faith Academy School	Norfolk	no	no	yes		
Norfolk Christian School	Norfolk	no	yes	yes		
Trinity Lutheran School	Norfolk	no	no	yes		
Emergency Shelters[1]		0	1	2	5	0
Willoughby Elementary	Norfolk	no	no	yes		
Tidewater Park Elementary	Norfolk	no	yes	yes		
Electric Substations		0	1	3	3	0
Sanitary Pump Stations		10	40	102	227	7
Water Pump Stations		0	0	1	2	0
Water and Wastewater Treatment Facilities		2	2	5	4	0
37th Street Water Plant[2]	Norfolk	no	no	yes	yes	no
Moores Bridges Water Plant[3]	Norfolk	no	no	yes	no	no
Virginia Initiative WWTP	Norfolk	yes	yes	yes	yes	no
Army Base WWTP	Norfolk	yes	yes	yes	yes	no
Atlantic WWTP	Virginia Beach	no	no	yes	yes	no
Chesapeake-Elizabeth WWTP	Virginia Beach	no	no	no	no	no
	Total	**12**	**45**	**123**	**260**	**7**

1 Some elementary schools double as emergency shelters, and therefore are not double-counted in the table. totals
2 Norfolk has recently implemented measures to prevent flooding of its water treatment plants (WTPs) up to elevation 13.70 feet NAVD88.
3 Ibid.

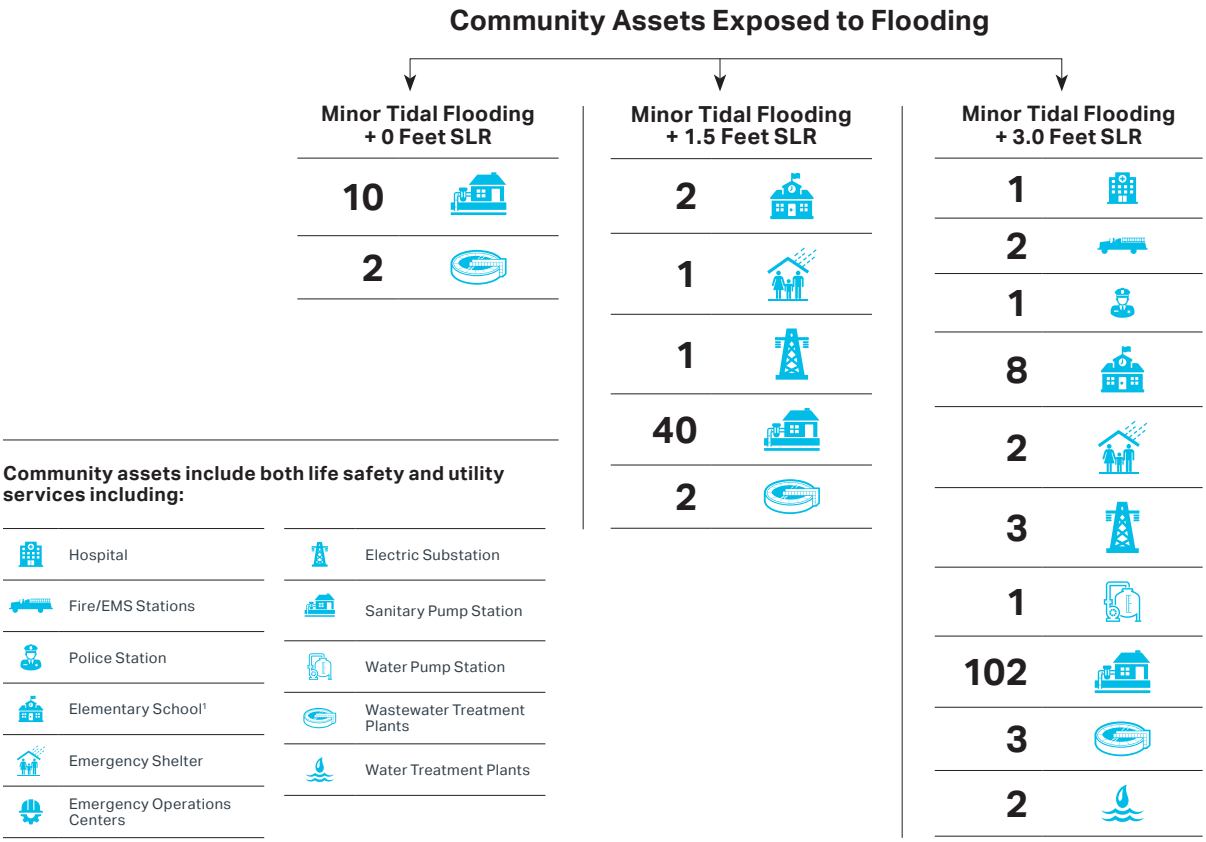


FIGURE 2-11: Community Assets Exposed to Flooding

[1]Two of the elementary schools impacted under the 3.0-foot SLR scenario also serve as emergency shelters

Although this analysis shows few significant minor tidal flooding impacts to community facilities under the SLR scenarios used in this study, it is important to note that a storm event could greatly exacerbate these impacts. Major storm events will need to be considered in the design and implementation of future mitigation and adaptation strategies for addressing stormwater and flood risk management to these specific assets. **Figure 2-12** shows the location of assets vulnerable to minor tidal flooding under current conditions, and with 1.5 and 3 feet of additional sea level rise.

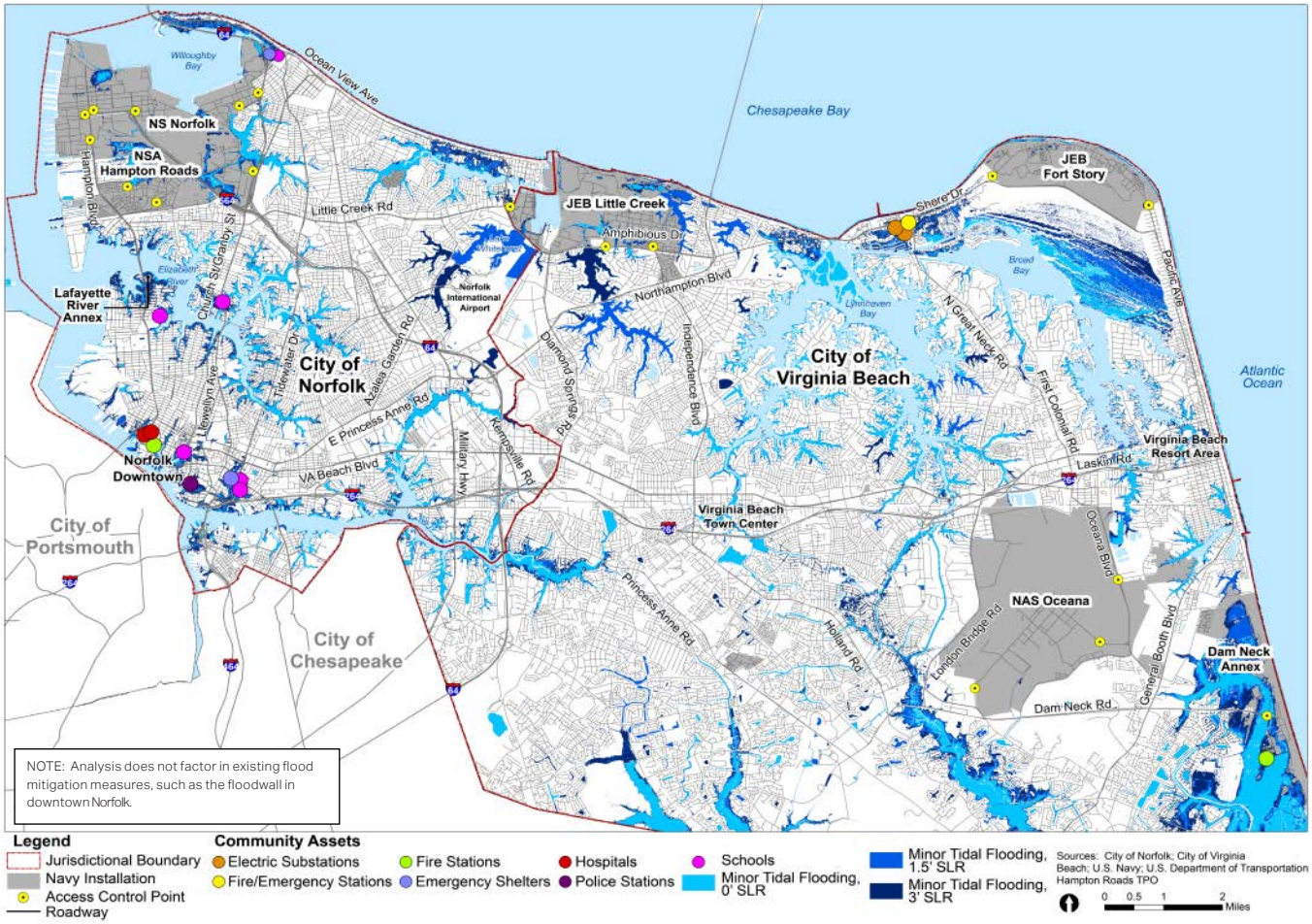


FIGURE 2-12: Community Asset Exposure Analysis

Impacts of Flooding on Access

While flood exposure to some community assets is problematic, flooded roadways can prove to be an even greater obstacle to accessing community facilities and services. Floodproofing assets or elevating them above the floodplain will provide minimal benefit to the greater community if large numbers of residents are unable to access the facility due to roadway flooding or flood-related congestion. If access to community facilities is greatly impeded or blocked, it impacts both the ability of staff who work at those facilities to get to work, and the ability of others to use those assets or services.

A more detailed network access analysis was performed in order to identify areas and assets whose access routes could be affected by flooding, even if the assets themselves are not directly impacted by flooding. This approach measures access from any given location in the community, and not access from a specific asset. With this approach, the process measured the ability to reach a specific kind of asset,and, if access is blocked, how close the next similar asset would be.

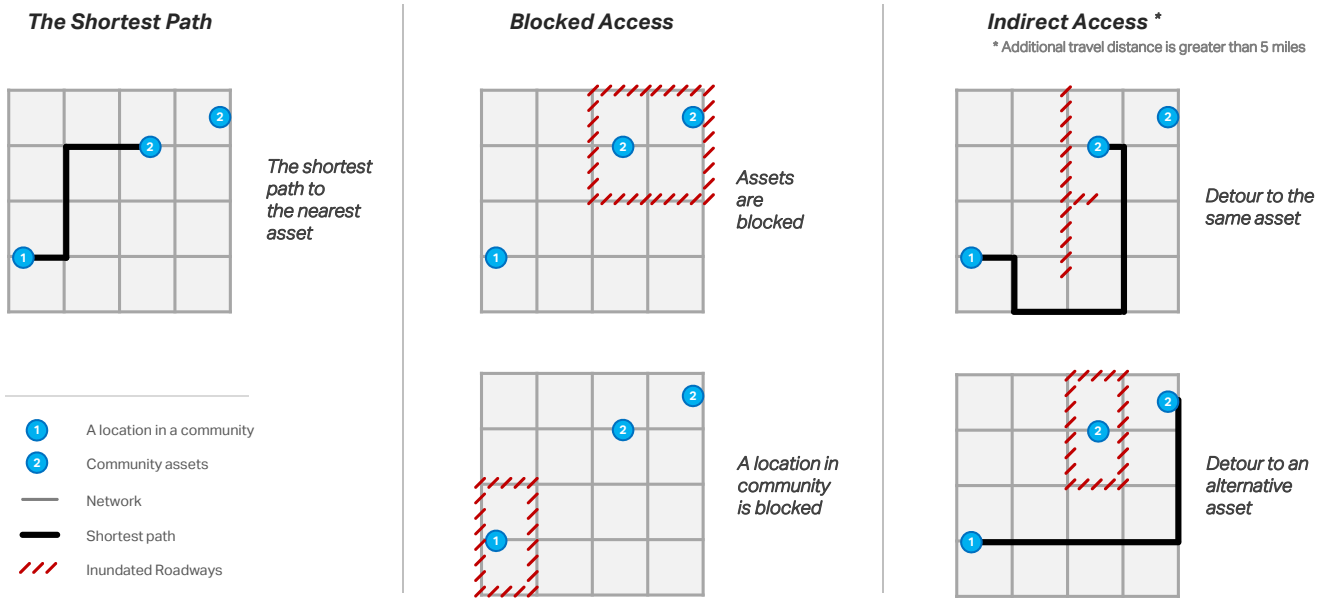


FIGURE 2-13: Access Analysis Explanatory Diagram

Access Analysis Definitions

- Blocked access (shown in red on the map) – All possible routes to the assets evaluated are blocked.
- Blocked or indirect access for two or more assets (shown in orange on the map) – Access to two or more community assets is blocked or "indirect" under the scenario. Indirect access is defined as requiring an additional five miles driving distance (or detour) to reach the asset.
- Blocked or indirect access for one asset (shown in yellow on the map) – at least one community asset is blocked or indirect and some assets may require a five-plus-mile detour, and, if access is blocked, how close the next similar asset is located. **Figure 2-13** provides a diagram demonstrating the access definitions.

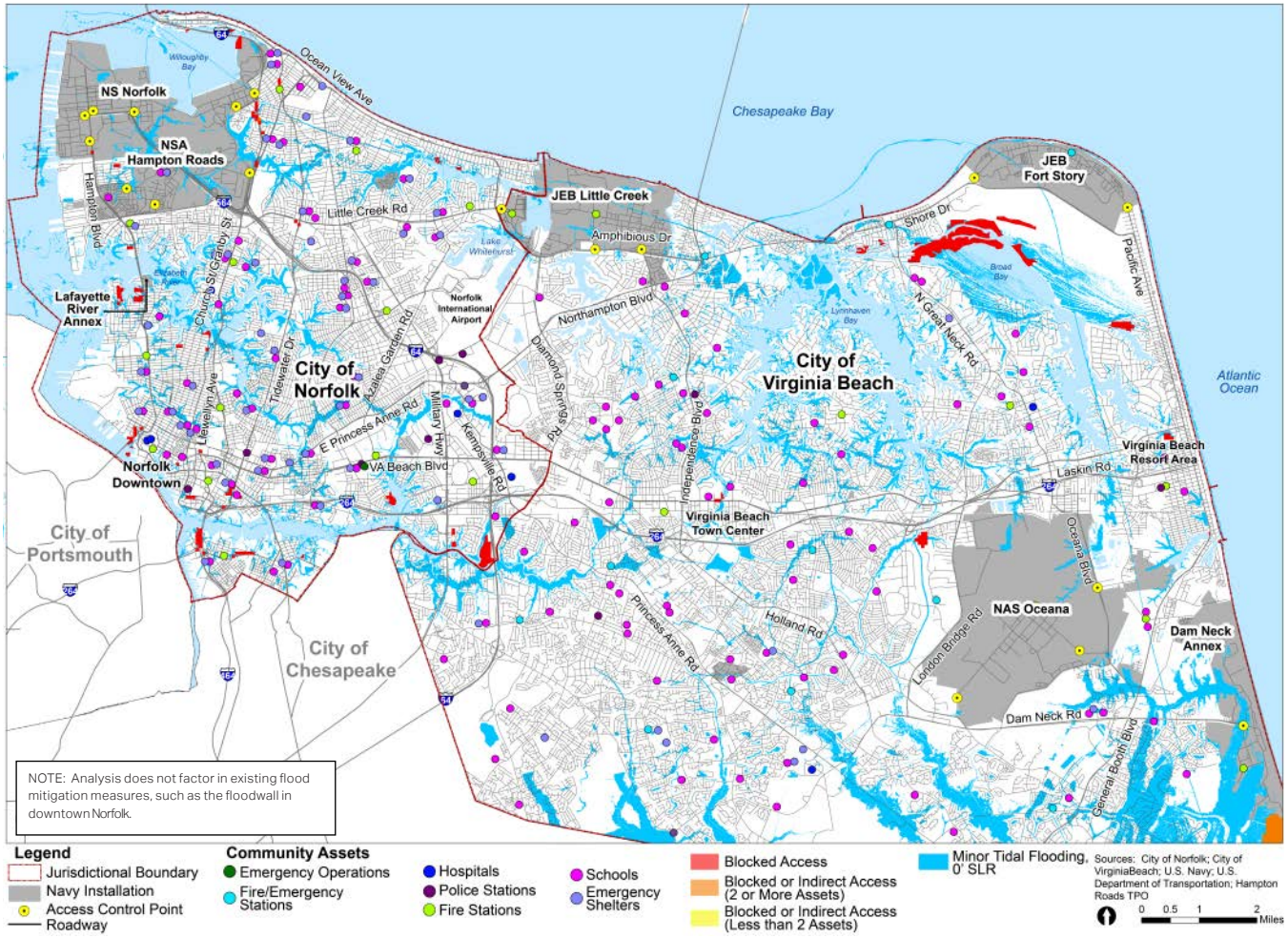


FIGURE 2-14: Access Analysis, 0.0' SLR

Figures 2-14, **2-15**, and **Figure 2-16** illustrate the results of the impact analysis by identifying areas that would have "blocked" or "indirect" access to their local community assets under each scenario.[24]

The access analysis examined a select set of assets, with a focus on those assets that residents and Navy personnel might need to access on a daily basis and / or in an emergency situation. The assets chosen have a direct impact on life-safety and military personnel readiness. Because Norfolk and Virginia Beach DoD and civilian residents do not personally require access to utility infrastructure, for example, those assets were not included in this analysis. However, DoD personnel may need to access an elementary school on a daily basis, or to a hospital in the event of an emergency. If these assets are not available, it could directly affect military personnel readiness. The assets analyzed for access impacts include:

24 Navy installations were included in the analysis to allow access to be measured leaving from the installation; however, installation boundaries were treated as a barrier when assessing access from outside the installation, since civilians are not normally permitted to use the installations as a throughway.

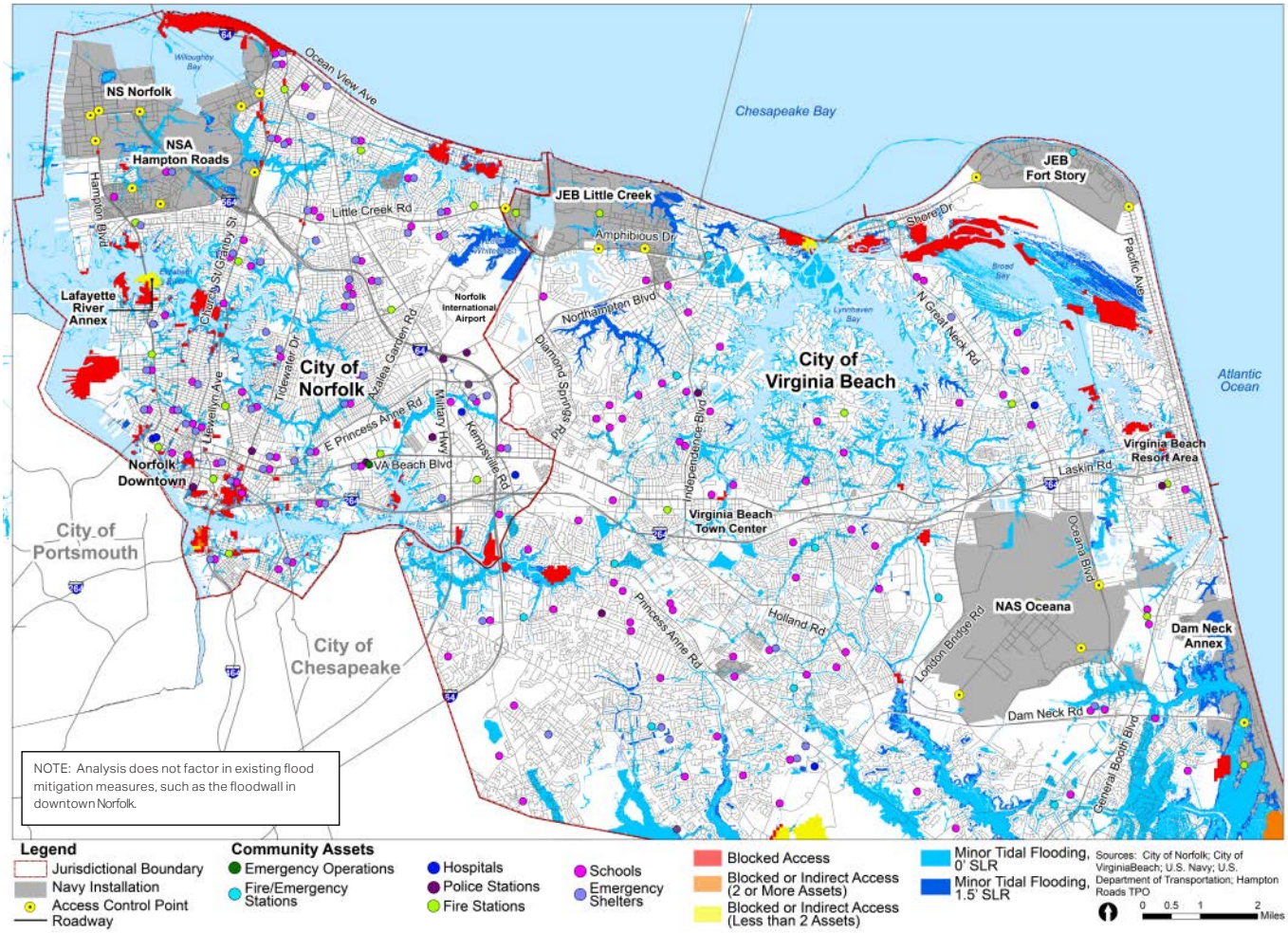


FIGURE 2-15: Access Analysis, 1.5' SLR

- Elementary Schools
- Hospitals
- Police Stations
- Fire Stations
- Emergency Operations Centers
- Emergency Shelters

Elementary schools (instead of middle or high schools) were used for the access analysis because 1) if access to elementary schools is blocked, military parents will likely have to stay home with younger children, thus impacting their ability to report for duty, and 2) elementary schools have smaller catchment areas, which tend to follow neighborhood boundaries and thus can illustrate access issues at a neighborhood level.

Under the current minor tidal flooding scenario in Norfolk and Virginia Beach (with no additional sea level rise), access issues are relatively minor. However, when 1.5 feet of sea level rise is added to minor tidal flooding, access issues occur in larger areas throughout both localities, and the impacts are more severe. When 3.0 feet of sea level rise is added to minor tidal flooding, access issues throughout the

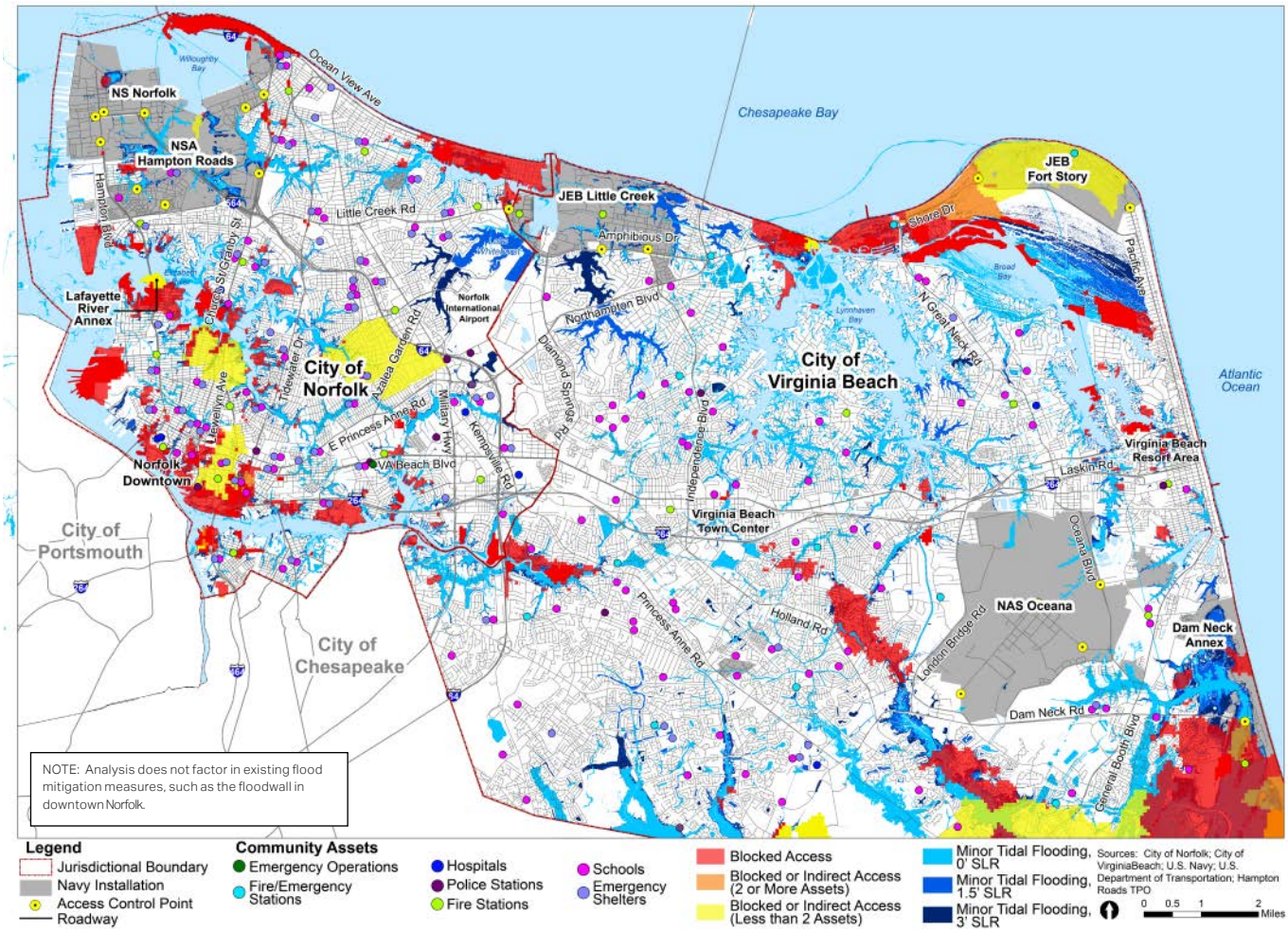


FIGURE 2-16: Access Analysis, 3.0' SLR

region are greatly exacerbated. Large sections of both Virginia Beach and Norfolk would experience blocked access to all assets evaluated, or would have trouble accessing two or more community assets. **Table 2-2** provides a consolidated list of the top five assets in each category that are most impacted by access under a 3.0-foot sea level rise scenario. Access to some of these assets could become blocked or indirect from certain areas under the current scenario. These areas would expand significantly under the 1.5-foot SLR scenario, and would extend even farther under the 3.0-foot scenario.

TABLE 2-2: TOP ASSETS EXPERIENCING IMPEDED ACCESS UNDER SEA LEVEL RISE SCENARIOS

		IMPEDED ACCESS		
ASSET NAME	CITY	0′ SLR	1.5′ SLR	3.0′ SLR
Fire Stations				
Fire 01 / EMS 22 – First Landing	Virginia Beach	X	X	X
Fire 21 / EMS 21– General Booth	Virginia Beach		X	X
Dam Neck Fire #52	Virginia Beach		X	X
Station Number 1	Norfolk	X	X	X
Station Number 16	Norfolk	X	X	X
Elementary Schools				
Sherwood Forest Elementary	Norfolk			X
Tidewater Park Elementary School	Norfolk	X	X	X
John B Dey Elementary School	Virginia Beach	X	X	X
Ocean Lakes Elementary School	Virginia Beach		X	X
Little Creek Elementary School	Norfolk	X	X	X
Police Stations				
First Precinct Police Station	Virginia Beach	X	X	X
2nd Precinct/ Training	Norfolk	X	X	X
Fire & Police Administration	Norfolk	X	X	X
Third Precinct Police Station	Virginia Beach	X	X	X
3rd Precinct/ Traffic Division	Norfolk	X	X	X
Shelters				
Rosemont Elementary School	Virginia Beach		X	X
Corporate Landing Middle School	Virginia Beach	X	X	X
Cox High School	Virginia Beach	X	X	X
Strawbridge Elementary School	Virginia Beach	X	X	X
Little Creek Elementary	Norfolk		X	X
Hospitals				
Sentara Princess Anne Medical Center	Norfolk	X	X	X
DePaul Hospital	Norfolk	X	X	X
Sentara Virginia Beach General Hospital	Norfolk	X	X	X
Norfolk Sentara Hospital		X	X	X
Children's Hospital of The Kings Daughters		X	X	X

2.4 UTILITIES

Reliable utility infrastructure is critical for ensuring that the military bases in the study area can function at optimal levels. Utility infrastructure interdependencies among the four installations and the two cities are high; the Navy relies on outside sources to provide power, water, and wastewater.[25] Furthermore, the stormwater management infrastructure charged with managing runoff often crosses city and federal jurisdictional boundaries or runs along major corridors that serve the installations. Roadway corridors such as Hampton Boulevard and Shore Drive often contain critical infrastructure in the right of way, and therefore, any upgrades to these corridors to address flooding and sea level rise should also consider ways to strengthen the resilience of utilities, including those service lines and infrastructure that directly serve the military.

Four primary infrastructure elements were reviewed as part of the utility network vulnerability analysis: electric power, water, wastewater, and stormwater.[26] Natural gas capacity was not identified as a specific vulnerability issue for the military during the analysis.

2.4.1 ELECTRIC

Dominion Energy supplies electricity to the Hampton Roads area, including the Navy installations involved in the JLUS. Any disruption of power could result in operational impacts to the Navy. While disruptions have been relatively minor in the past, opportunities may exist to strengthen power infrastructure to improve reliability of service to the Navy.

Any upgrades to improve the resilience and reliability of the power grid and transmission infrastructure are the responsibility of Dominion Energy and not the Navy or cities. An effort was made to identify specific vulnerabilities in the network; however, data from Dominion Energy was not publicly available to perform detailed analysis of the power network.[27] In addition, the Navy raised security concerns about identifying specific vulnerabilities in the report. Most of the Navy installations involved in the JLUS indicated that some level of electrical infrastructure redundancy is in place.

According to the Sandia National Laboratories Report, *Development of an Urban Resilience Analysis Framework with Application to Norfolk, VA*, Dominion Energy has been systematically raising breakers and transformers in flood-prone areas. Dominion has also been re-routing control system conduits to enter at the top of the substations instead of through the bottom, to ensure that they are accessible during flood events. In addition, Dominion Energy indicates that it has a standardized process whereby a set number of substations are evaluated annually to determine vulnerability.[28] This evaluation determines if the stations must be elevated, floodproofed, or moved, depending on the age and life cycle of the facility. According to Dominion Energy, the life of a new substation is 40 years and Dominion Energy is currently planning for a 1.5-foot water elevation as it designs improvements to existing stations or designs new stations. Dominion Energy would not release a list of completed or planned station upgrades. Dominion also has a strategic initiative to bury selected tap line distribution power lines that are most prone to outages. Tap lines bring electricity into neighborhoods from primary or main feeder lines that connect back to substations.

25 The exception to this is the JEB Fort Story installation, where the water and wastewater systems are managed through a public-private venture.
26 Telecommunications infrastructure is not a focus of this JLUS.
27 Open source energy infrastructure data were obtained from the Department of Homeland Security and were used as part of the analysis.
28 Interview with Mark McVey and Robert Allison, Dominion Energy, 6/5/2017.

The Navy maintains backup power generation to critical facilities. If power is lost, the backup generation is engaged. These systems are typically diesel-powered and require regular refueling and maintenance by the Navy to ensure they remain operable. Fuel storage on base is used to fill the generators. However, in a prolonged power outage, the bases rely on outside delivery to replenish diesel supplies, which could be hampered by roadway flooding conditions. Access is also an important factor for repairing power lines and infrastructure.

Having access to alternative sources of renewable energy is one possible way of increasing power network reliability. A back-up source of power that is not dependent on the power grid, such as solar, could provide power to a portion of an installation during a major storm event. NAS Oceana recently entered into an enhanced use lease agreement with Dominion Energy for a 90-acre solar panel array on the southwest corner of the installation that will generate 18 megawatts of electricity. The project is built on Navy property and will provide the installation with a redundant line to Dominion's main power grid. However, an agreement for the installation to receive power directly from the solar panels in the event of an emergency is not part of the interconnect agreement. NS Norfolk also has a 10-acre solar farm that can generate up to 2.1 megawatts of electricity, and the installation maintains a power purchase agreement with a 110-acre solar farm located in North Carolina, helping to diversify its power portfolio.

2.4.2 WATER AND WASTEWATER

Reliable water and wastewater service is critical to the long-term viability and quality of life of the region. The adaptability of such systems to temporary or permanent impacts from flooding and sea level rise will likely be tested in the decades ahead. While no major service issues were identified by the Navy or stakeholders as current concerns, the location of some critical water and wastewater facilities puts them at increased exposure and risk for damage.

Sea level rise can impact water and sewer infrastructure in multiple ways. According to a report by McKim and Creed, *Protection of Critical Water Infrastructure from Sea Level Rise*, the impacts of rising seas on water utilities include:

- Decreased access to critical infrastructure facilities.[29]
- Increased flooding at low-lying wastewater treatment facilities.
- Increased infiltration of salt water into wastewater collection systems or pump stations, which can impact capacity and water treatment. However, according to Norfolk's Public Utilities Department, Norfolk's reservoirs would not be impacted by 3.0 feet of sea level rise. Even if the water supply system itself is not impacted, a loss of power to any of the pump stations responsible for pumping fresh water can cause an interruption in water service. In both cities, some of the water pump stations, but not all, are equipped with back-up generators. According to the EPA's *Power Resilience Guide for Water and Wastewater Utilities,* "an extended power loss can have devastating impacts on drinking water and wastewater utilities and the communities they serve. Inoperable pumps at a drinking water utility can make firefighting difficult and cause local health care facilities and restaurants to close. A loss in pressure can result in contamination entering the drinking water distribution system from surrounding soil and groundwater. For wastewater utilities, losing pumps may lead to direct discharge of untreated sewage to rivers and streams or sewage backup into homes and businesses."[30]

29 Burkett, Curtis and Craig Wells. *Protecting Critical Water Infrastructure from Sea Level Rise.* McKimm & Creed, March 2017.
30 Office of Water. *Power Resilience Guide for Water and Wastewater Utilities.* U.S. Environmental Protection Agency, December 2015.

The Norfolk Department of Utilities is the regional drinking water purveyor, providing drinking water for Norfolk, Virginia Beach, parts of Chesapeake, and the Navy. Norfolk's Utilities Department oversees the distribution of drinking water throughout Norfolk, and maintains an expansive infrastructure network, in addition to owning and maintaining the City's sanitary sewer system. Norfolk's raw water comes from eight reservoirs located throughout southeastern Virginia and is pumped to one of the City's two water treatment plants to be treated and filtered. Norfolk recently upgraded the water main along Hampton Boulevard, and the city's FY2020–2023 CIP proposes $17 million in annual spending to improve the City's wastewater collection system and an investment of around $150 million to improve and upgrade the water system." [31] Norfolk is also currently in the process of updating its design and construction standards for both its water and wastewater infrastructure. These new standards will include a requirement that the finished floor elevation of wastewater pump stations be elevated to 3 feet above the 100-year floodplain.[32] Norfolk's *2015 Flood and Wind Vulnerability Assessment* assessing the vulnerability of its two water treatment plants and large raw water pump station in Suffolk recommends strategies to protect this infrastructure to a critical flood elevation of 13.70 feet NAVD88. The city has since implemented these recommendations.[33]

Norfolk is also currently in the process of conducting an asset management analysis of its water transmission mains and pump stations.[34] The pump station asset management plan will consider sea level rise and flooding in its risk assessment and recommendations for which pump stations should be prioritized for upgrades.[35]

Virginia Beach's Department of Public Utilities distributes drinking water throughout Virginia Beach, and oversees and maintains its expansive municipal distribution system, as well as the city's sanitary sewer system/infrastructure. Virginia Beach's current design standards require that its sanitary sewer pump stations be designed to have a finished floor elevation that is at least 3 feet above the base 100-year flood elevation. Additionally, Virginia Beach has been conducting sanitary sewer evaluation studies, and installing watertight manhole inserts and cleanout plugs in the city cleanouts where they are deemed necessary. Because the design life of its pump stations is only 40 years, Virginia Beach has not implemented a program to elevate existing stations, unless they are being replaced; however, they have done some site-specific floodproofing on a case-by-case basis.[36]

HRSD provides sewer collection and wastewater treatment services to the cities of Norfolk and Virginia Beach. Sewage is transported through Norfolk's and Virginia Beach's municipal sewer systems to HRSD's larger interceptor pipes, which feed into the wastewater treatment plants. HRSD operates four WWTPs in the study area: the "Army Base" WWTP, located adjacent to NIT; the Virginia Initiative WWTP in the Lambert's Point neighborhood in Norfolk; the Chesapeake Elizabeth WWTP at JEB Little Creek in Virginia Beach;[37] and the Atlantic WWTP near Dam Neck Annex in Virginia Beach.

31 *City of Norfolk Capital Improvement Plan, FY 2020–2023*. City of Norfolk, April 2019.
32 Per email from Cherryl Barnett, PE, City of Norfolk Utilities Department, April 22, 2019
33 *Flood and Wind Vulnerability Assessment and Hazard Mitigation Plan for Selected Water Production Infrastructure*. City of Norfolk, July 2015.
34 Per comments from Kristen Lentz, Director of Utilities for the City of Norfolk, received March 26, 2019
35 Per email from Cherryl Barnett, PE, City of Norfolk Utilities Department, April 22, 2019
36 Per email from Stephen T. Motley, PE, Engineering Division Manager for the City of Virginia Beach Department of Public Utilities, received April 9, 2019.
37 HRSD indicates this plant will be shut down in 2021 and the site will likely be used for storage.

According to HRSD, its biggest flood-related challenge is difficulty accessing pump stations and plants during and after major weather events, due to downed trees and flooded roadways. More specifically, flooding in and around Dam Neck Annex, near the Atlantic Waste WWTP, impacts HRSD's ability to access the plant. No specific plans for upgrading the Atlantic WWTP plant were defined; however, HRSD is upgrading and floodproofing pump stations in other areas, including the Larchmont neighborhood in Norfolk. HRSD recently adopted new design standards that require that new structures built in the floodplain in Norfolk be elevated to base flood elevation plus 3 feet of freeboard; in Virginia Beach, HRSD requires that HRSD structures be elevated to base flood elevation plus 2 feet of freeboard.[38] HRSD is also planning to conduct a study assessing the resilience of its infrastructure to flooding and sea level rise.[39]

The vulnerability analysis shows that 10 sanitary pump stations are exposed to minor tidal flooding, 40 could be impacted by flooding with an additional 1.5 feet of sea level rise, and 102 sanitary pump stations could be exposed to flooding with 3.0 feet of sea level rise on top of present levels. Only one potable water pump station was shown to be impacted under the 3.0-foot sea level rise scenario, with no impacts currently or with 1.5 feet of sea level rise. The analysis showed potential flooding impacts to HRSD's Virginia Initiative WWTP in Norfolk, and the Army Base WWTP at NIT, from minor tidal flooding. These two plants could also be affected under a 1.5-foot sea level rise scenario. Two Norfolk water treatment plants could also be impacted by 3.0 feet of sea level rise: 37th Street and Moore's Bridges. In addition, HRSD's Atlantic WWTP in Virginia Beach could be impacted. However, as previously noted, the City has recently implemented measures to prevent flooding of critical infrastructure up to elevation 13.70 feet NAVD88.

2.4.3 STORMWATER

Undersized and/or inadequately maintained stormwater infrastructure can cause or exacerbate flooding issues on roadways and adjacent properties. It is difficult, therefore, to separate a discussion about stormwater infrastructure from transportation flooding issues. Specific roadway-related flooding issues are discussed earlier in this chapter; specific issues related to stormwater management and maintenance in areas that have experienced flooding but are not directly transportation related are identified in this section.

Because of the high water table in southeastern Hampton Roads, natural infiltration of stormwater is limited. The way that stormwater is managed on both federal, city-owned, and private property impacts the volume of runoff that must be managed elsewhere. In some areas the mix of federal, city, and private stormwater infrastructure makes it more challenging to develop a comprehensive solution to this flooding concern. Maintaining the stormwater infrastructure so it can function as intended is also a challenge, especially for the Navy where staff resources and funding are limited.

Each locality owns its own stormwater infrastructure, which is managed and maintained by the cities' public works departments. Norfolk owns and operates 13 pump stations and several hundred miles of stormwater pipe and Virginia Beach owns and operates 16 stormwater pump stations and nearly 1,000 miles of stormwater pipe. Virginia Beach's *Stormwater Master Plan Update* models, currently under development, will include open channels, pipes 24 inches in diameter and larger, and overland flow paths in all of the city's 31 drainage basins. This model will help Virginia Beach to better manage, maintain, and improve its stormwater system going forward, by giving the City a more comprehensive

38 Hampton Roads Sanitation District, HRSD Design and Construction Standards, January 2018
39 Per email from Rob Martz with HRSD, received April 8, 2019

understanding of existing drainage patterns that may not currently be taken into account by its existing stormwater infrastructure.[40]

Likewise, the Navy owns and maintains stormwater management infrastructure that is located on base. However, as previously mentioned, runoff from the installations often ends up in the localities' stormwater systems, and vice versa. Varying design standards and inconsistent maintenance regimes across the network can contribute to degraded system performance in some areas.

Without more detailed modeling, it is difficult to pinpoint exactly where roadway flooding is caused or exacerbated by inadequate stormwater infrastructure. However, that infrastructure is the "first line of defense" in terms of managing minor tidal or precipitation flooding. In addition to the roadway vulnerabilities described in Section 2-2, several areas that experience flooding related to stormwater capacity or maintenance were identified through discussions with stakeholders, including:

- Flooding along Mason Creek. This tidal water body drains to Willoughby Bay through a large box culvert under a portion of NS Norfolk. The culvert has a tide gate that is operated to mitigate tidal surges from entering Mason Creek but tailwater pressure from a high water surge in the bay can cause a buildup of stormwater runoff in Mason Creek, contributing to flooding in the Mason Creek and Northside neighborhoods.
- Flooding along the stretch of Hampton Boulevard south of its bridge over the Lafayette River, and near to NSA Hampton Roads Lafayette River Annex.
- Flooding on NS Norfolk that is worsened by a crushed outfall pipe on Boush Creek on the installation that could potentially also be contributing to flooding in the Glenwood Park neighborhood.
- Stormwater drainage from the area around Lake Bradford, and from ditches south of Shore Drive through portions of JEB Little Creek, into Little Creek Harbor. JEB Little Creek stakeholders reported flooding at the on-base Boone Clinic that may be associated with this drainage system.
- Frequent flooding of the Amphibious Drive Bridge at JEB Little Creek. This is a significant issue, as Amphibious Drive provides the only on-base connection between the two sides of the installation. If Amphibious Drive is blocked due to flooding, this affects emergency response, and impedes the explosive-handing route. Shore Drive is the only alternative route, so responders must exit the base to use Shore Drive, and then return, which slows response times.
- Flooding from a culvert near Bells Road gate near NAS Oceana can contribute to gate access delays.
- Potential flooding of roadway underpasses along Hampton Boulevard and I-564 if power to the pumps that keep them clear is lost. If power is lost to a stormwater pump, the pumps have approximately 3-5 days' worth of fuel to provide back-up power generation capabilities before the generators would need to be refueled. Flooding on the I-564 underpasses could block access to four access control gates at NS Norfolk, which could cause major backups at the remaining gates, and require some service members to have to make significant detours to access the installation.

40 CDM Smith. "Virginia Beach Stormwater Master Plan Model: Model Content and Application Technical Guidance." Presentation, Virginia Beach, VA, July 7, 2018. https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/slr-masterplan-model-pres-7-8-18.pdf .

Both cities have allocated significant levels of funding towards upgrading their stormwater, utility, and transportation infrastructure as part of their current capital improvements programs. Norfolk's updated 2019 budget includes several million dollars of upgrades that include improvements to street infrastructure, initiatives to address street flooding, and upgrades to the city's stormwater system.[41] Virginia Beach's CIP for 2018–2023 has budgeted nearly $130 million in improvements to the sewer system, and about $65 million in improvements to water. The City has undertaken a study to complete a watershed-based assessment of the impacts of recurrent flooding and sea level rise on the City's infrastructure, homes, businesses, and community assets. When the study is complete, it will include recommendations for how the City can improve the resilience of its infrastructure and utility systems.[42]

Table 2-1 presented earlier provides a summary of the findings of the exposure analysis for utility infrastructure. Much of the utility network follows the roadway corridors in both localities, and therefore, impacts to roadway access can also affect the ability of the cities and the other utility providers to access critical utility infrastructure for repair or maintenance. Direct access to utility infrastructure is of greatest concern for the utility providers, as they need regular access to substations, pump stations, wastewater treatment plants, etc. to perform critical maintenance and repair operations.

2.5 SUMMARY – TARGET AREAS FOR ACTION

The results of the analyses led to the identification of four sub areas where vulnerabilities are anticipated to have potential impacts on regional infrastructure or community assets the Navy relies upon. The identification of sub areas was a helpful step toward establishing regional priority areas, and can serve as a guide for cross-jurisdictional coordination. The sub areas are shown in **Figure 2-17**.

Area 1 Summary

Key Issues: Infrastructure reliability and access to NS Norfolk and NSA Hampton Roads. Home to both NS Norfolk and NSA Hampton Roads, this area has the highest jobs to housing ratio and the highest number of miles of roadway that will potentially be flooded under a 3.0-foot sea level rise scenario. The Hampton Boulevard corridor is a key connection between NS Norfolk and downtown, as well as the many residential neighborhoods to the south and east of the installations. According to the *Hampton Roads 2045 Socioeconomic Forecast and Transportation Analysis Zone Allocation Report*, moderate population growth is expected in the areas immediately adjacent to the NS Norfolk and NSA Hampton Roads installations, placing increased importance on reinforcing infrastructure reliability and maintaining access. The 2045 TAZ analysis forecasts employment growth increases of more than 100 percent in several TAZs in this sub area between 2015 and 2045, which will also put increased pressure on roadways and nearby community facilities.[43]

41 *City of Norfolk Capital Improvement Plan, FY 2020-2023*. City of Norfolk, April 2019.
42 Email from CJ Bodnar, City of Virginia Beach, February 19, 2019.
43 *Hampton Roads 2045 Socioeconomic Forecast and TAZ Allocation Report*. Hampton Roads Transportation Planning Organization, February 2019.

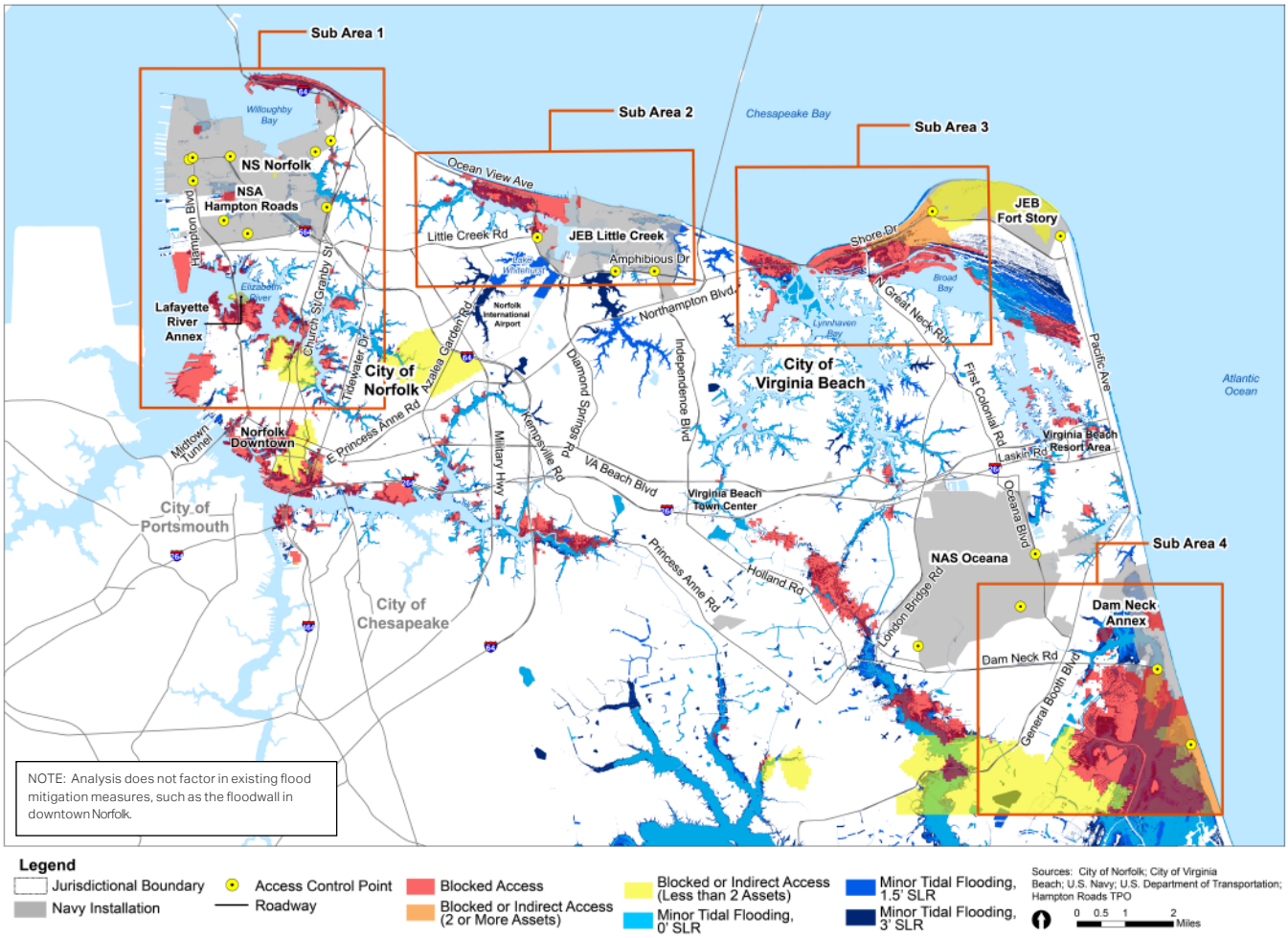


FIGURE 2-17: Sub Areas

Area 2 Summary

Key Issues: Shore Drive flooding and underperforming stormwater systems and flooding at JEB Little Creek. Area 2 encompasses the JEB Little Creek installation and the neighborhoods immediately to the east and west, including the East Beach neighborhood in Norfolk, and most of the Chic's Beach neighborhood in Virginia Beach. This area includes sections of the W. Ocean View, Shore Drive, E. Little Creek, and Northampton Boulevard corridors, which provide important east-west connections between Norfolk and Virginia Beach. Modest population growth, according to the 2045 TAZ projections, is projected for the neighborhoods immediately adjacent to the installations between now and 2045.[44] These additional residents will need access to community assets and services, and would most likely contribute to an increase in traffic around the base. Although the TAZ analysis projects modest job growth for the surrounding area, the Navy's *Fiscal Year 2017 Department of the Navy Economic Impact Report* shows significant job growth on the JEB Little Creek installation (a 25 percent increase between 2016 and

44 Ibid

2017). If the installation continues to add jobs, this could increase congestion on the roadways leading to the base.[45]

Central infrastructure vulnerabilities include roadway flooding along Shore Drive and stormwater management infrastructure that may be contributing to flooding at JEB Little Creek. Roadway flooding in this area can also block access to critical entry points, such as Gate 1.

Area 3 Summary

Key Issues: Flooded roadways and blocked access between JEB Little Creek and JEB Fort Story and adjacent neighborhoods. Area 3 is located between JEB Little Creek and JEB Fort Story. This area provides a critical connection between both installations, and between the northwestern and northeastern halves of Virginia Beach. Access to parts of this area could potentially be cut off due to flooded roadways under the 3.0-foot SLR scenario, thereby eliminating access to JEB Fort Story, neighborhoods flanking Shore Drive, and nearby community assets. JEB Little Creek-Fort Story personnel have also reported recurrent flooding at Fort Story Gate 6, which has significant impacts on access to the installation. The 2045 TAZ analysis projects very little population growth in this sub area in the coming years, but does estimate that some areas along Shore Drive will add a significant number of new jobs in that time period – again, this would put additional traffic on the Shore Drive corridor, which is of particular concern when also considering the potential impacts of future sea level rise.[46]

Area 4 Summary

Key Issues: Flooded roadways and blocked access on Sandbridge Road and Dam Neck Annex.
Area 4 includes the southeastern quadrant of NAS Oceana, Dam Neck Annex, and the neighborhoods to the south of both installations, including parts of the Princess Anne neighborhood adjacent to Westneck Creek, Woodhouse Corner, Pungo, and Sandbridge. This area includes sections of Dam Neck Road and Nimmo Parkway, both of which provide important east-west connections between the western part of Virginia Beach and the coast, and links NAS Oceana to Fentress Airfield in Chesapeake, an auxiliary landing field for Oceana. The 2045 TAZ projections show a population increase in the areas encompassing NAS Oceana and Dam Neck Annex of more than 100 percent, as well as several nearby TAZs that could experience at least a 50 percent increase in jobs over the 30-year time period, which could place significantly increased pressure on existing community assets and services, and could increase traffic congestion near the installations.[47] When Sandbridge Road floods (currently during tidal flooding and sometimes during heavy rainfall events), the road is closed, and public traffic is re-routed north through South Gate entry control point at Dam Neck Annex, since there is no alternative route. This creates security challenges for the base related to force protection.

45 *Fiscal Year (FY) 2017 Department of the Navy Economic Impact Report*. Norfolk, VA: U.S. Navy, November 14, 2017.
46 *Hampton Roads 2045 Socioeconomic Forecast and TAZ Allocation Report*. Hampton Roads Transportation Planning Organization, February 2019.
47 Ibid

3 TARGET AREA ACTIONS

Recommendations to address the challenges are broken out into three categories: Actions, Conversations, and Regional Coordination Strategies. Each recommendation embodies one or more of the overarching JLUS goals and attempts to comprehensively address as many of the challenges identified in the target area as possible.

This JLUS has identified 22 Actions, 23 Regional Coordination Strategies, and 7 Conversations.

22 Actions address challenges identified in specific target areas that impact access to the installations and/or critical community facilities, stormwater and flood risk management, or utility reliability. The Actions are numbered based on their overall score, in **Figure 3-1.** The Action number scoring is discussed in more detail in the following section.

23 Regional Coordination Strategies address issues related to coordination and outreach; advocacy, policy, and development regulations; and technology and data. They identify opportunities to work together more effectively, by improving processes and policies that promote more consistency on issues of importance to the JLUS partners. High priority regional coordination strategies are discussed in Chapter 4. Additional strategies that were discussed, but were either not identified as a priority, or that were outside the scope of the study, are included in the Appendix.

7 Conversations are topics that require further discussion and exploration among JLUS stakeholders to determine whether an idea should be studied further. Conversations may lead to agreement that further study is needed or that a certain course of action should be pursued. Conversations are described in the Appendix.

3.1 EVALUATION CRITERIA AND SCORING

A set of 15 criteria were established to evaluate how well each Action addresses the JLUS goals and reduces overall risk to military readiness. The criteria are organized into four categories: Installation Readiness, DoD Personnel Readiness, System Performance and Design, and Co-Benefits. Conversations are not scored, as the ideas require further exploration and discussion before their relative merits can be determined. As previously noted, Regional Coordination Strategies presented in Chapter 4 were identified as high priority by the Technical Committee and Policy Committee. Strategies not falling into this category are included in the Appendix.

The 15 criteria were presented to the Technical Committee, and then refined based on committee guidance. All 15 criteria were originally assigned a value of one at the outset. However, due to the Technical Committee's desire to put stronger emphasis on installation and personnel readiness, criteria in each of those categories have been given a weighting multiplier of 3 and 2, respectively. This prioritizes those Actions which could potentially have a more direct benefit to the military. The following descriptions explain the four main criteria categories shown in **Table 3-1** in more detail:

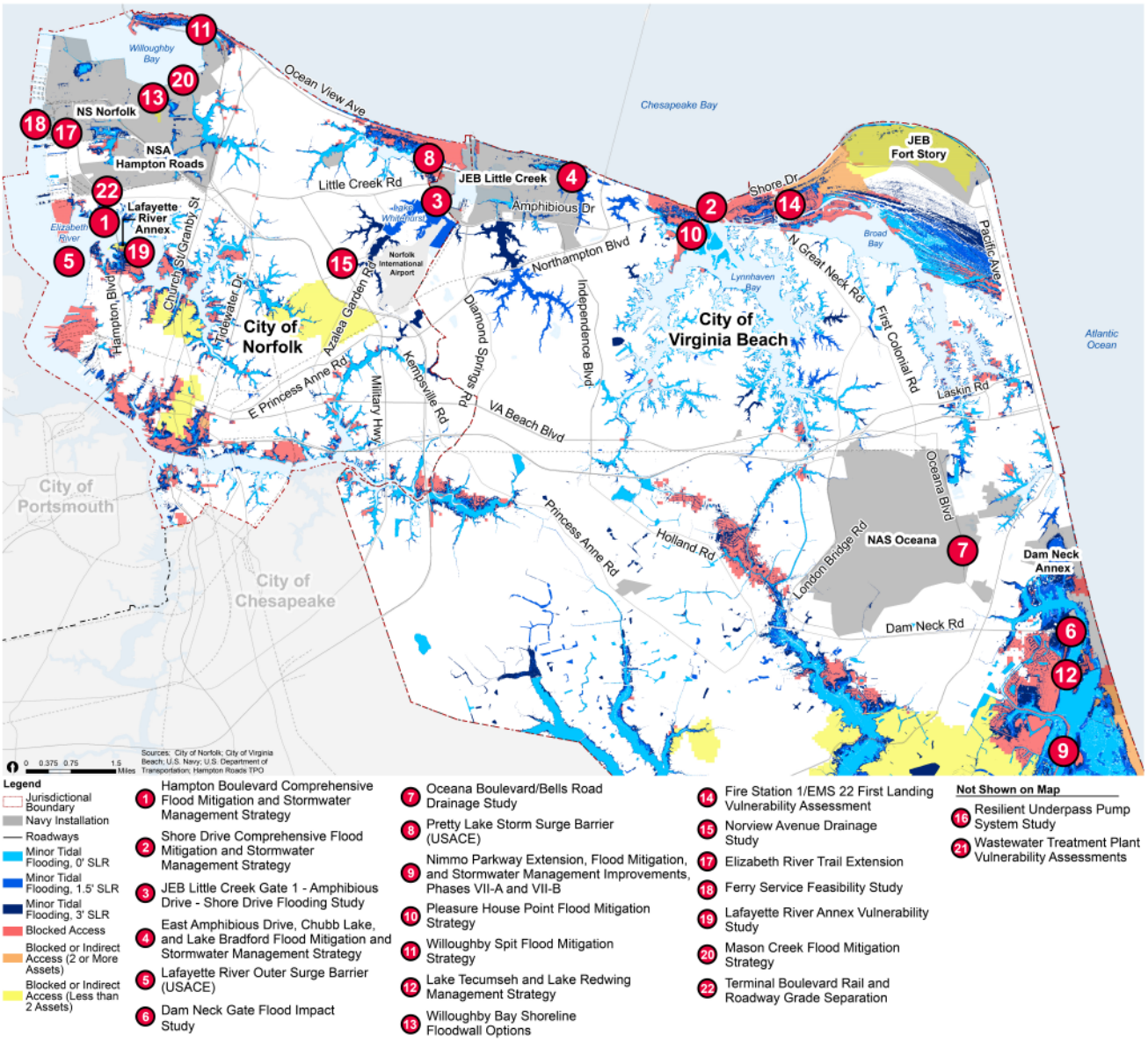


FIGURE 3-1: Recommended JLUS Actions

Installation Readiness: The four criteria in this category consider how an Action reduces flood risk to assets directly serving the DoD, including strategic corridors that are essential for maintaining access to military installations, as well as specific structures and/or other DoD assets. Criteria in this category also consider whether an Action could improve the reliability of utilities serving the installations, or if the Action is located along a corridor that provides access to more than one installation. A total of 12 points (3 points per criterion) are available in this category, based on the applied weighting that emphasizes installation readiness as a top priority consideration.

DoD Personnel Readiness: The three criteria in this category consider whether a project could support military personnel readiness by improving access to

the services or assets personnel rely upon outside the installations. The criteria consider whether the Action is located in a zip code that is home to a higher number of DoD commuters, indicating that the area has a higher concentration of military personnel and families than other areas in Hampton Roads. In addition, the criteria consider whether an Action could reduce the physical flood risk to an individual community asset, or improve overall access to those community assets in areas where flooded roadways could fully or partially prevent people from reaching them. A total of 6 points (2 points per criterion) are available in this category, based on the weighting that recognizes DoD personnel readiness as a priority.

Co-Benefits: The four criteria in this category consider the potential co-benefits and broader resiliency factors, beyond military readiness, that could be created through the implementation of an Action. These criteria consider whether a project could create potential opportunities for community recreation and/or healthy activity, could benefit community assets in some way, could create ecosystem benefits (depending on how the project is designed and implemented), and whether or not the proposed Action is generally consistent with local land use goals and priorities. The potential for generating co-benefits will, in most cases, be dependent upon more detailed design and engineering solutions. Each Action that meets criteria in this category receives 1 point per criterion, except the criterion on whether the proposed Action meets local land use goals and priorities. Actions considered inconsistent with local land use goals and priorities lose 1 point. A total of 3 points are available in this category, and no weighting is applied.

TABLE 3-1: JLUS EVALUATION CRITERIA

INSTALLATION READINESS	Project reduces flood risk along a DoD Strategic corridor
	Project reduces vulnerability to flooding of DoD structure/asset
	Project improves utility reliability for DoD installation
	Project improves access to more than one DoD installation
DOD PERSONNEL READINESS	Project serves a ZIP code with a high number of DoD commuters
	Project reduces vulnerability of community assets that DoD personnel rely upon (via retrofit or rebuild)
	Project improves access in areas with blocked/indirect access to community assets that DoD personnel rely on
CO-BENEFITS	Project creates potential community recreation/health opportunities
	Project benefits a community asset (or multiple community assets)
	Project creates potential ecosystem benefits (water quality, habitat)
	Project is inconsistent with local land use goals and priorities
SYSTEM PERFORMANCE AND DESIGN	Project reduces current flood risk to communities
	Project creates potential green infrastructure opportunities
	Project benefits multiple jurisdictions
	Project is adaptable to future conditions/considers future flood risk and sea level rise impacts

System Performance and Design: The four criteria in this category consider whether a project reduces a current flood risk to the community, creates a potential for green infrastructure elements as part of a future design or engineering effort, potentially benefits more than one jurisdiction, and/or could be adapted to address future risks caused by flooding/ sea level rise. A total of 4 points are available in this category, and no weighting is applied.

Scoring Breakdown

Table 3-2 provides a list of the Actions sorted by action number and score. Actions can receive a maximum of 25 potential points based on the value assigned to each criteria. **The top two highest-scoring Actions are comprehensive flood mitigation and stormwater management strategies along primary roadway corridors serving the DoD.** These Actions directly address challenges that impact access to at least one of the Navy installations included in this JLUS, and embody the JLUS goal of "reliable and resilient access routes for DoD personnel."

Higher overall scores indicate Actions that most directly address military readiness and provide additional co-benefits for the surrounding community. Most of the higher-scoring Actions address both ongoing/current flooding and access issues, and also take into account the risks associated with future sea level rise. Several of the lower-scoring Actions address issues in areas where the flood risk is currently low or moderate, but may be higher under future sea level rise scenarios.

Overall, Action scores are the primary indicator of priority for implementation. Other implementation factors, such as the associated SLR risk time frame related to each action (as applicable), the current funding status, and whether the action has advanced forward in the planning or design phase, are discussed in Chapter 6, Implementation Plan. These factors are intended to help inform the level of effort that could be required to move an Action forward, recognizing that some Actions will be more complex than others, and funding availability may shift how Actions are prioritized, in order to take advantage of resources.

3.2 JLUS ACTIONS

Each of the 22 Actions is described in more detail beginning in Section 3.2.1. The Actions are presented in order by a reference number that correlates to **Figure 3-1**. The proposed Action, need for action, benefits, and implementation steps and factors are described along with the scoring breakdown for each action. In addition, the recommended lead responsible party to initiate the action and supporting partners are identified. Each Action also includes a cost range and a list of potential funding sources. Providing a useful cost estimate for implementation of Actions is difficult at the early stages of planning. Estimated costs for each Action have been defined in general terms using broad ranges, and/or are based upon the cost estimates noted in other studies, where applicable. The defined cost ranges attempt to reflect the potential cost for more detailed study, design, and construction of a solution. The ranges are as follows:

- $100 – $500K $
- $500k – $1M $$
- $1M – $10M $$$
- $10M – $25M $$$$
- >$50M $$$$$

TABLE 3-2: RECOMMENDED JLUS ACTIONS

ACTION #	ACTION	SCORE	LOCALITY	INSTALLATIONS SERVED*
1	Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy	19	Norfolk	NSN, NSA HR, LRA
2	Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy	19	Virginia Beach	JEB LC – FS
3	JEB Little Creek Gate 1 - Amphibious Drive - Shore Drive Flooding Study	18	Norfolk, Virginia Beach	JEB LC – FS
4	East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy	17	Virginia Beach	JEB LC – FS
5	Lafayette River Outer Surge Barrier (USACE)	16	Norfolk	NS Norfolk, NSA HR, LRA
6	Dam Neck Gate Flood Impact Study	15	Virginia Beach	NAS Oceana-Dam Neck Annex
7	Oceana Boulevard/Bells Road Drainage Study	15	Virginia Beach	NAS Oceana-Dam Neck Annex
8	Pretty Lake Storm Surge Barrier (USACE)	15	Norfolk	JEB LC – FS
9	Nimmo Parkway Extension, Flood Mitigation, and Stormwater Management Improvements, Phases VII-A and VII-B	14	Virginia Beach	NAS Oceana-Dam Neck Annex
10	Pleasure House Point Flood Mitigation Strategy	14	Virginia Beach	JEB LC – FS
11	Willoughby Spit Flood Mitigation Strategy	14	Norfolk	NSN
12	Lake Tecumseh and Lake Redwing Management Strategy	11	Virginia Beach	NAS Oceana-Dam Neck Annex
13	Willoughby Bay Shoreline Floodwall Options	11	Norfolk	NSN
14	Fire Station 1/EMS 22 First Landing Vulnerability Assessment	9	Virginia Beach	JEB LC – FS
15	Norview Avenue Drainage Study	9	Norfolk	JEB LC – FS
16	Resilient Underpass Pump System Study	9	Norfolk	NSN, NSA HR, LRA
17	Elizabeth River Trail Extension	8	Norfolk	NSN, NSA HR, LRA
18	Ferry Service Feasibility Study	8	Norfolk	NSN, NSA HR, LRA
19	Lafayette River Annex Vulnerability Study	8	Norfolk	LRA
20	Mason Creek Flood Mitigation Strategy	8	Norfolk	NSN
21	Wastewater Treatment Plant Vulnerability Assessments	8	Norfolk, Virginia Beach	NSN, NSA HR, LRA, JEB LC – FS, NAS Oceana-Dam Neck Annex
22	Terminal Boulevard Rail and Roadway Grade Separation	7	Norfolk	NSN, NSA HR, LRA

***Acronyms Used in Table 3-2**

NSN – Naval Station Norfolk

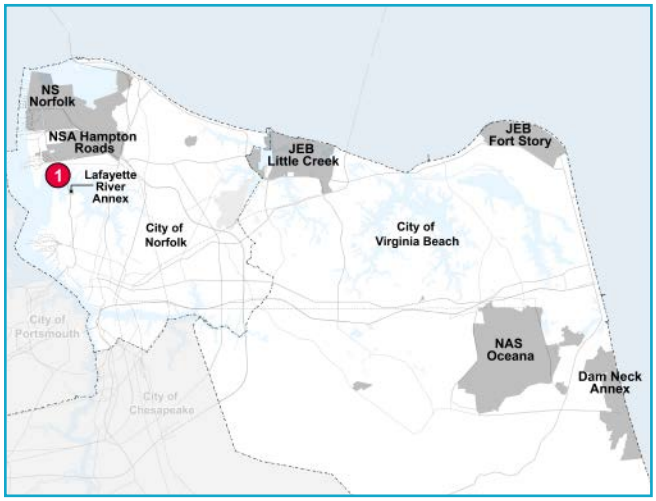
NSA HR – Naval Support Activity Hampton Roads

LRA – Lafayette River Annex

JEB LC – FS – Joint Expeditionary Base Little Creek - Fort Story

3.2.1 Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy

1



This Action recommends the development of a comprehensive approach to address current and future flooding along the Hampton Boulevard corridor that considers Norfolk, U.S. Navy, and VA Port Authority infrastructure. The strategy should explore a range of measures, including increased stormwater infrastructure capacity and roadway elevation options, to address both recurrent flooding today and long-term sea level rise over time.

Action Score: 19

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **3**

System Performance and Design: **3**

Hampton Boulevard is a highly urbanized, major north-south roadway in Norfolk linking multiple major economic engines for the region, including NS Norfolk, NSA Hampton Roads, and Norfolk International Terminals (NIT), one of the properties that makes up the Port of Virginia. This corridor provides direct access from downtown Norfolk and the Midtown Tunnel to critical DoD assets, and is a primary route to connect NS Norfolk to Special Area Craney Island Fuel Depot to the west and Lafayette River Annex to the south.

The Need for Action

Recurrent nuisance flooding already occurs along portions of Hampton Boulevard, which can impact access to installation gates at NS Norfolk, as well as access to NIT. Flooding north of the Lafayette River is primarily due to storm surge events and/or heavy rainfall, whereas recurrent flooding south of the river occurs in tidal and storm surge events, rainfall events, and combinations of these types of events. Over time, the corridor will become even more vulnerable to flooding, as sea levels rise and the intensity and frequency of storm surge and rainfall events increase.

The conditions along Hampton Boulevard vary, and therefore the conditions in the north and south segments of the corridor are discussed separately. However, in order for the corridor to continue to provide access, both segments will need to be addressed together in the recommended comprehensive strategy.

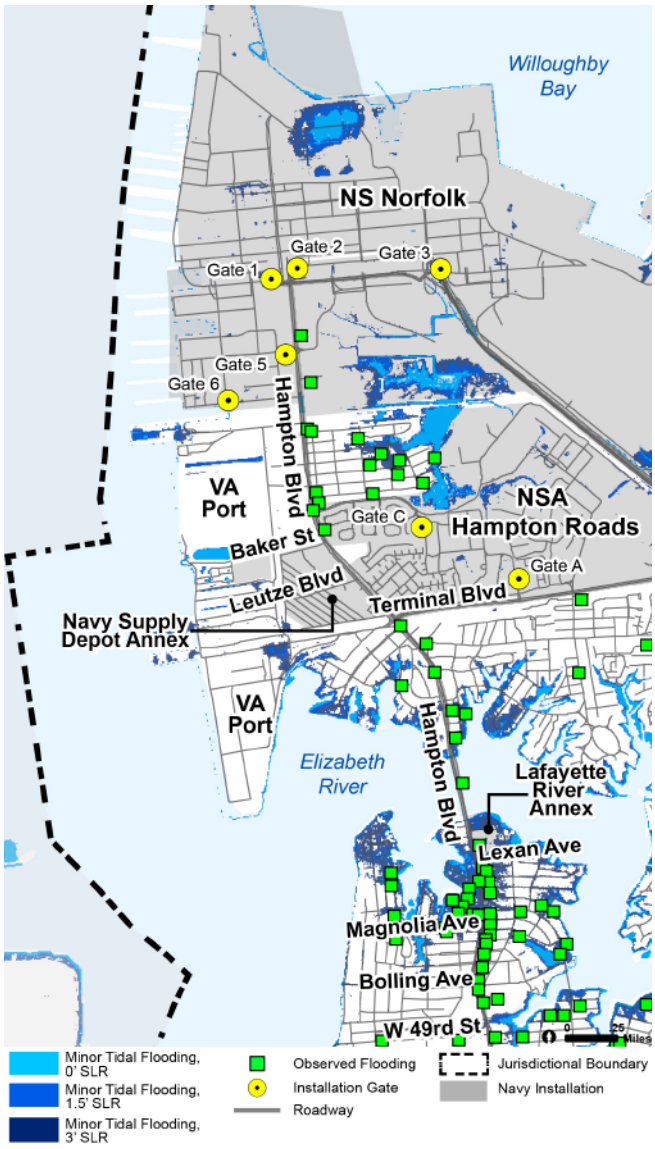


FIGURE 3-2: Action 1: Sea Level Rise Scenarios and Historical Flood Complaints

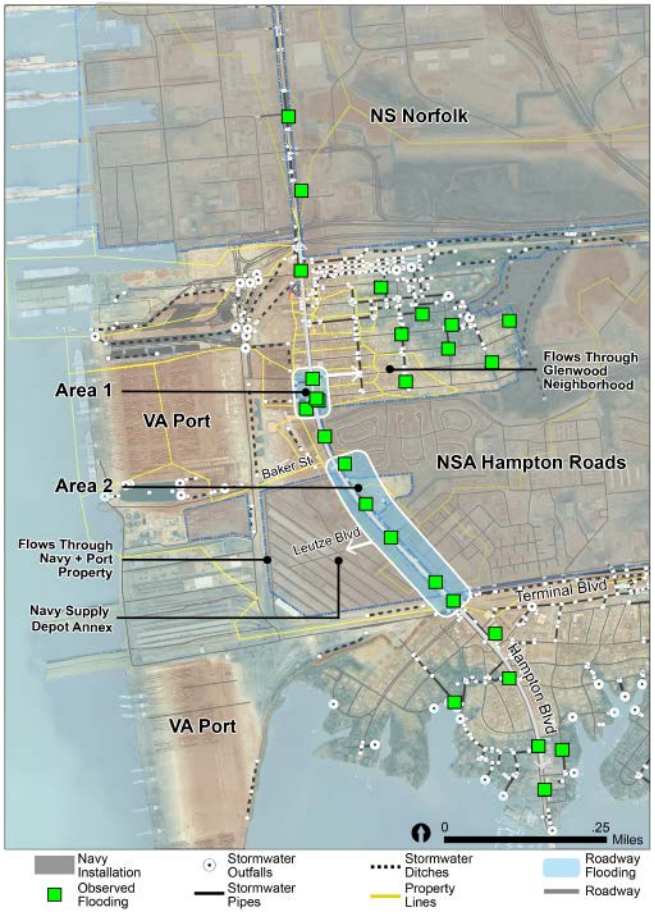


FIGURE 3-3: Action 1: Hampton Boulevard (North): General Drainage Patterns

Northern Segment

Flooding along the northern segment of Hampton Boulevard impacts access to gates 1, 2, 5, and 6 at NS Norfolk, Gates B and C at NSA Hampton Roads, and Helmick Street, which provides access to the Ben Moreell Family Housing area at NSA Hampton Roads. In addition, flooding along this segment limits access to NIT, causes congestion, and raises safety concerns. The primary construction vehicle and personnel entrance to NIT is off of Hampton Boulevard via Baker Street. Homes, businesses, and other community facilities located along the Hampton Boulevard corridor, including Sewells Point Elementary School and the NSA Fire Station No.4 near Baker Street, also experience access issues during heavy rain events.

Stakeholder input indicated that portions of the southbound lane of Hampton Boulevard in this area are frequently impassable during storm events. This issue is common at the intersection of Hampton Boulevard and Baker Street, and causes significant delays that result in vehicles diverting through

adjacent parking lots to avoid standing water. These issues are compounded during peak gate access and departure times at NS Norfolk and NIT.

Much of the current roadway flooding along this segment occurs because the existing stormwater system is unable to convey rainfall quickly enough. Furthermore, high tidal water levels at the stormwater outfalls could further inhibit the system's ability to drain the street. **Figure 3-2** shows historical Norfolk flood observation data that confirms frequent flood occurrences along the corridor, and how flooding will impact the corridor and surrounding streets under each SLR scenario.

The existing stormwater infrastructure along the northern segment is owned and maintained by Norfolk, the U.S. Navy, and the Virginia Port Authority. Based on available data, it appears that stormwater flows travel through a combination of Norfolk, Navy, and Virginia Port Authority property pipe infrastructure before discharging into the Elizabeth River. The outfall from this system does not have a tidal backflow prevention device. The collection and conveyance systems were designed and built independently over time and have been connected in an effort to manage the overall stormwater requirements of the corridor. A comprehensive analysis of the three systems has not been performed and is needed.

Figure 3-3 illustrates the general drainage pattern along the northern segment of Hampton Boulevard. Drainage from Area 1 travels through the Glenwood Park subdivision, ultimately discharging to tidal waters through a series of ditches within the boundaries of NSA Hampton Roads and NS Norfolk. The Glenwood Park neighborhood is a residential area on the east side of Hampton Boulevard, bordered on the east by Captain Slade Cutter Athletic Park, which sits within NSA Hampton Roads, south of NS Norfolk. The neighborhood is home to a significant number of military families.

Prior to the 1940s, the neighborhood drained to Willoughby Bay through the tidal Boush Creek. In the late 1930s and 1940s, land within NS Norfolk was filled, including Boush Creek, to create the airfield and other facilities. The neighborhood and a short segment of Hampton Boulevard now drain into a series of ditches along the perimeter of the airfield and through a long culvert with an outfall in the installation's Willoughby Bay shoreline. The culvert does not have a tide gate or other backflow preventer, and high tidal tailwater levels can contribute to flooding directly and indirectly (by inhibiting stormwater drainage) both in the neighborhood and along Hampton Boulevard.

Flooding within the Glenwood Park neighborhood can cause access issues along some streets. Additional sea level rise will only exacerbate the current flooding issues, as shown in **Figure 3-4**.

Drainage from Area 2, between Baker Street and Terminal Boulevard, is collected at Leutze Boulevard, and appears to connect to the river under Navy and Virginia Port Authority property. Norfolk stormwater pipes draining from inlets on both the northbound and southbound lanes travel parallel to the street within the Hampton Boulevard right of way, converging in a 24-inch pipe at Porter Road. Historical street flooding has been observed at this location where the pipes converge. Norfolk's GIS layers do not show City pipes continuing from this location. Navy stormwater networks show a 22-inch x 34-inch pipe running from this junction westward under the Navy Supply Depot Annex. At its western end, the large Navy pipe ends very near pipes within the NIT drainage system, which run westward to outfall on the Elizabeth River. It is reasonable to assume that flow from Norfolk's pipes is connected to the Navy and Virginia Port Authority pipes.

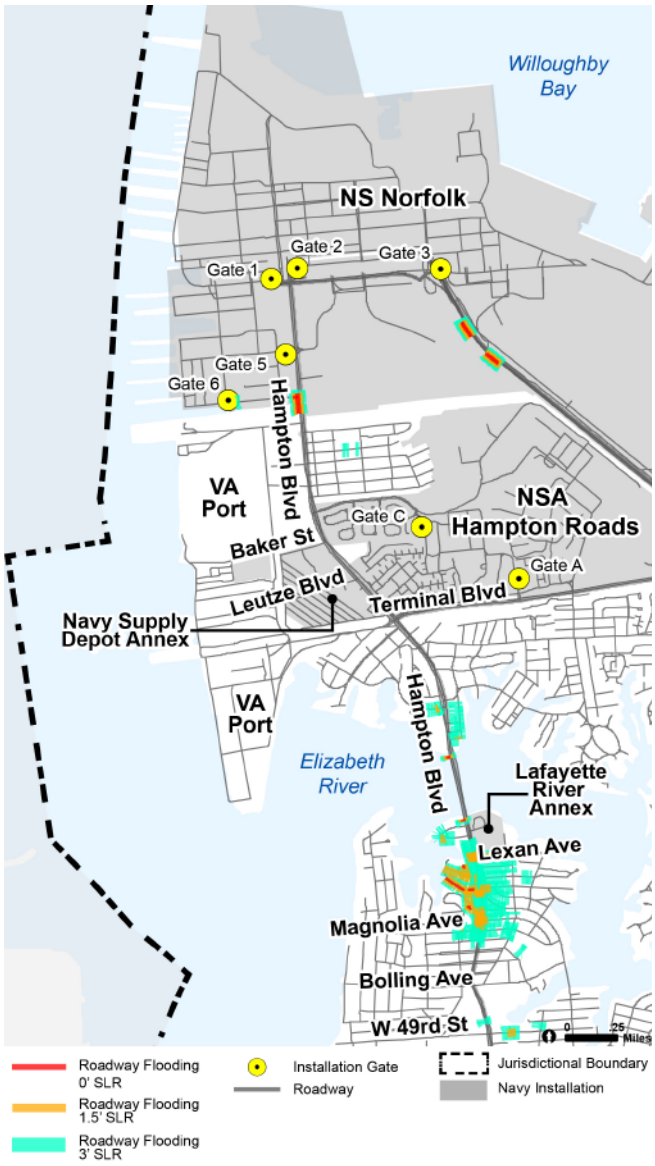


FIGURE 3-4: Action 1: Transportation Infrastructure Vulnerability

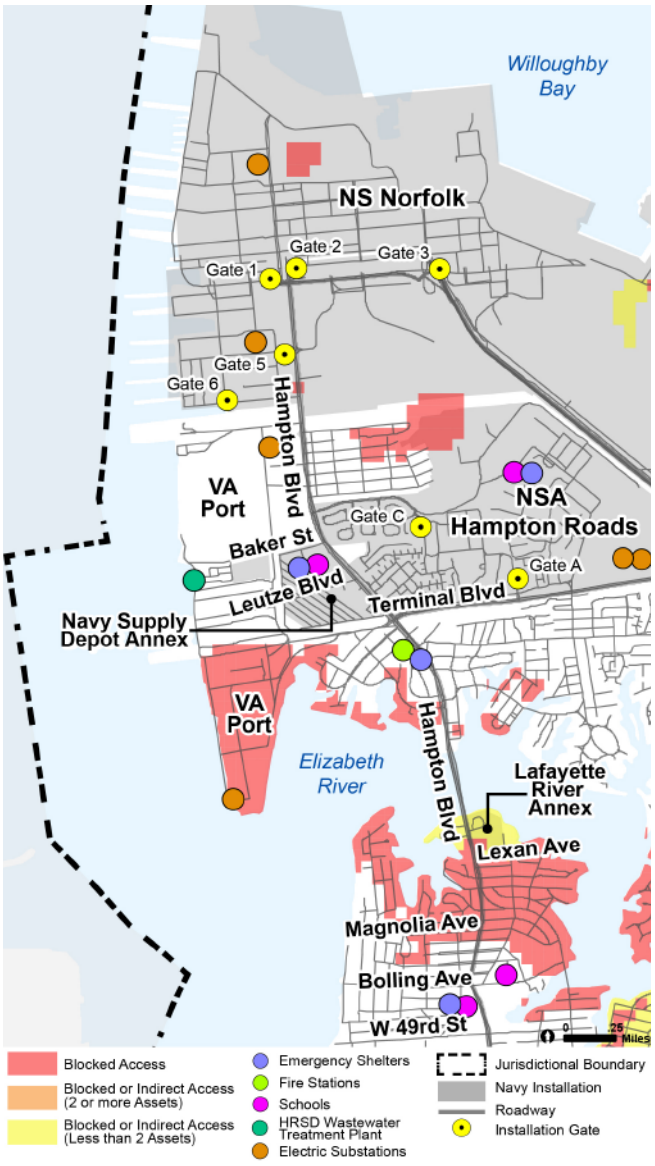


FIGURE 3-5: Action 1: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

Southern Segment

The segment of Hampton Boulevard south of the Lafayette River Bridge is already prone to recurrent flooding, and will become even more vulnerable as sea levels continue to rise. Recurrent flooding at the intersection of Hampton Boulevard and Lexan Avenue, which is adjacent to the entrance to Lafayette River Annex, is an ongoing issue that impacts access to the Annex, and all points north, including the NSA Hampton Roads main installation, NS Norfolk, and NIT. Recurrent flooding from tidal events/storms routinely impacts this intersection, and at certain depths, it becomes impossible to cross.

Under this condition, access from the south is cut off to all three Navy properties along Hampton Boulevard, and military readiness is significantly impacted.

Figure 3-5 shows potential access issues under a scenario of 3.0 feet of sea level rise with minor tidal flooding along the corridor. In the northern segment, flooding could prevent access to the nearby elementary school that also serves as an emergency shelter. Roadway flooding could also impact the surrounding neighborhoods, impeding or even blocking access into and out of neighborhood streets and impeding access to places of work or other community facilities. Access for much of the neighborhood surrounding Lafayette River Annex would be significantly constrained under this scenario.

Proposed Action

This Action recommends the development of a comprehensive strategy for managing stormwater and flooding along the Hampton Boulevard corridor. This Action will require data sharing and additional collaboration between Norfolk, the Navy, and NIT to investigate and confirm the conditions and connections between the various pipe systems. The following components should be considered in the development of the strategy:

- A comprehensive and detailed hydrologic and hydraulic model of the existing stormwater drainage system should be developed to confirm causes of historical flooding, and to test design concepts with present conditions/future sea level scenarios. Wetland delineations and environmental impact documentation would likely be required for any significant work to maintain and improve the drainage system. The model should integrate Norfolk, Navy, and NIT stormwater management systems.
- The Navy's plans for redevelopment of the Navy Supply Depot Annex near Leutze Boulevard and stormwater management enhancements already underway at NIT should be integrated into the strategy. Any proposed modifications by the Navy to the Lafayette River Annex property should also be considered for potential impact/benefit along the corridor.
- The possibility of disconnecting some inlets from the neighborhood's stormwater system along the northern segment of Hampton Boulevard near the Glenwood Park neighborhood should be considered. The Hampton Boulevard inlets could potentially be re-routed to drain westward to the Elizabeth River. Field investigations to confirm the dimensions and state of repair of the existing ditches and pipes, including those that are on Navy property downstream of the neighborhood, are recommended.
- Maintenance of existing ditches and pipes connecting Glenwood Park to Willoughby Bay through Navy property should also be considered to ensure that all of the potential storage and conveyance benefits of the existing system are being realized. Existing stormwater pipes may need to be enlarged to improve conveyance and add localized storage, if possible with existing ground elevations.
- Options for adding a pump station near the drainage system's outfall on Willoughby Bay to overcome tidal tailwater pressures and drain stormwater during high tide events should also be considered, particularly in future sea level rise scenarios. A low-capacity package pump station may be considered, but a higher-capacity pumping station on Navy property near the system's outfall on Willoughby Bay may be a better long-term solution for both NS Norfolk and the Glenwood Park neighborhood, as sea level rise begins to make it more difficult to gravity drain the ditches around the runway and taxiways.

- The strategy should build upon the work Norfolk is currently doing to evaluate and repair existing stormwater management infrastructure, as well as the prior *Hampton Boulevard Drainage Study* (Blakeway Study), which includes a series of strategies. The study recommended constructing a plunge pool and a tide gate at the outfall west of Hampton Boulevard (at the end of Richmond Place), and adding a new 30-inch outfall pipe in addition to the existing outfall pipe. Subsequent phased recommendations included similar improvements (plunge pool and tide gate) to the outfall at Richmond Crescent. The study also recommended upstream conveyance improvements, including additional curb inlets and increasing pipe sizes to drain runoff, as beneficial for addressing precipitation flooding. Raising the elevation of Hampton Boulevard at the intersection with Lexan Avenue was also recommended, if deemed necessary, following installation of the outfall and conveyance system improvements.
- Norfolk should continue to explore the technical feasibility of, and pursue funding for, adding backflow preventers on stormwater outfalls and increasing the size of the stormwater pipes, especially in the southern segment of the corridor.
- Raising a portion of the Hampton Boulevard roadway in the southern segment should be explored through a series of roadway design alternatives that fully explore options for adapting the roadway to the long-term impacts of flooding and sea level rise. These alternatives can provide an understanding of potential impacts and benefits associated with a change in the road geometry.
- Other opportunities for additional green infrastructure, and opportunities to improve connections to the existing Elizabeth River Trail, should also be explored as part of this Action
- Hampton Boulevard is also addressed as part of a model project in Chapter 5, which discusses initial options and approaches for mitigating current flooding.

Action Benefits

- Identifies opportunities to reduce current and future flood risk along a primary corridor serving the DoD that provides direct access to NS Norfolk, NSA Hampton Roads, and Lafayette River Annex.
- Identifies opportunities to maintain access to NS Norfolk, NSA Hampton Roads, and Lafayette River Annex, reducing delays for military personnel.
- Identifies opportunities to maintain access to downtown Norfolk, NIT, businesses, community assets, and neighborhoods all along Hampton Boulevard.
- Identifies opportunities to improve access to community facilities that DoD families rely upon, such as fire stations and elementary schools that also serve as emergency shelters.
- Identifies opportunities for corridor design enhancements that integrate green infrastructure and ecosystem benefits.
- Could Identify opportunities to reduce on-site flood risk to nearby community assets, such as Camp Allen Elementary School.
- Should consider opportunities for improving walkability and safety along the corridor and at key intersections as part of infrastructure upgrades.
- Addresses future conditions, including the impacts of additional sea level rise.
- Should identify opportunities to enhance community recreation.

Implementation Steps

1. Formalize coordination between Norfolk, the Navy, and the Virginia Port Authority for developing a comprehensive stormwater management and flood mitigation strategy.
2. Define a scope of work to include additional field investigations, joint modeling, and analysis to accurately define various drainage systems and performance levels, as well as the development and exploration of a full range of mitigation measures for the corridor.
3. Identify and pursue potential funding sources for the study.
4. Utilize Blakeway Study as a baseline for an expanded H&H study that expands the project area from the original study, in order to determine the impacts of making drainage improvements on both Hampton Boulevard and the surrounding neighborhoods.
5. Leverage other ongoing corridor and/or master plan processes that could affect stormwater infrastructure in this area, including Norfolk, NS Norfolk, NSA Hampton Roads, and Virginia Port Authority development projects.
6. Coordinate with the city and the USACE to ensure that the USACE recommended project for an Outer Surge Barrier on the Lafayette River is taken into account.
7. Once Action funding is secured, develop a joint committee to oversee study progress.
8. Require consideration of long term maintenance and operation of any proposed infrastructure upgrades as part of project design and implementation.
9. Identify phasing and jointly pursue funding for project implementation.

Other Actions proposed along the Hampton Boulevard corridor could have an impact on the development of the strategy and should therefore be monitored:

- Action #5: Lafayette River Outer Surge Barrier (USACE)
- Action #19: Lafayette River Annex Vulnerability Study

Lead: Norfolk

Partners: U.S. Navy, Virginia Port Authority, VDOT, HRPDC

Funding and Approval Status

- No funding is in place for study of this Action. Norfolk is using its on-call contracting process to make urgently needed stormwater infrastructure repairs along the corridor and is in the process of assessing its functionality.
- No official coordinated planning or design work has been initiated for this specific Action.

Cost Range

- $$$$ ($10M – $25M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

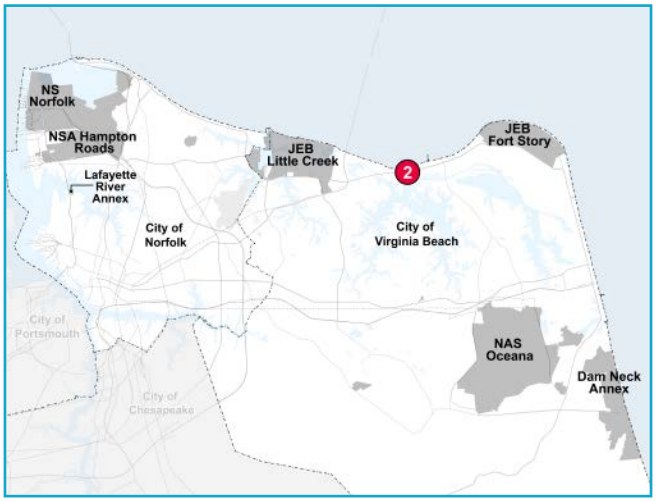
Potential Funding Sources

- Norfolk CIP Funding
- Virginia's Transportation Funding (VDOT, Department of Rail and Public Transportation (DRPT))
- VA DCR Dam Safety and Floodplain Management Grants
- VA Department of Environmental Quality (DEQ) Stormwater Local Assistance Fund

- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- U.S. DoD OEA Implementation Grants
- U.S. Department of Transportation (DOT) National Infrastructure Investments-BUILD Transportation Planning Grants
- Federal Highway Administration (FHWA) National Highway Performance Program
- FHWA Defense Access Road Program
- U.S. HUD Community Development Block Grant (CDBG) Entitlement Program
- Virginia Port Authority

3.2.2 Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy

2



This Action recommends the development of a comprehensive approach to address current and future flooding along a 4-mile segment of Shore Drive that connects JEB Little Creek and JEB Fort Story.

Action Score: 19

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **3**

System Performance and Design: **3**

Shore Drive is a heavily-traveled east-west corridor that connects JEB Little Creek and JEB Fort Story. Flooding on the roadway impacts access to both installations; in the future, sea level rise could impact access to community assets and emergency services for both DoD personnel and civilians. Access along Shore Drive is critical to installation and personnel readiness for both installations.

The Need for Action

Historical flood complaint data from the City of Virginia Beach documents multiple complaints about recurrent flooding on the Shore Drive corridor at several points, including on both the eastern and western sides of the Lesner Bridge, as shown in **Figure 3-6**. With 3 additional feet of sea level rise, several segments of the roadway would become vulnerable to flooding, as shown in **Figure 3-7**. Access to JEB Fort Story from Shore Drive could be completely cut off over time due to flooding.

The Shore Drive corridor west of the bridge has not been as extensively studied as the eastern part of the corridor, as the current flooding impacts on this side of the bridge tend to be less severe than those on the eastern side. However, recurrent flooding west of the bridge has been cited as a concern for military readiness, and western Shore Drive's vulnerability to flooding increases in future sea level rise scenarios.

In addition to military readiness impacts, under a 3.0-foot SLR scenario, a significant portion of the neighborhoods along Shore Drive would also experience blocked access to community assets,

such as fire stations and elementary schools, as shown in **Figure 3-8**. Three additional feet of sea level rise could also cause flooding impacts to a Dominion Energy electric substation and Fire Station 1/EMS 22 First Landing, as shown in **Figure 3-9**.

If Shore Drive is unavailable, military personnel trying to access JEB Fort Story would need to travel an additional 15 miles, either by backtracking to get on I-64/I-264, or by taking Virginia Beach Boulevard all the way to the oceanfront, then taking Route 60/Pacific Avenue to reach an alternate gate, adding significant time to their commute. This could also significantly impact emergency response capabilities in the area.

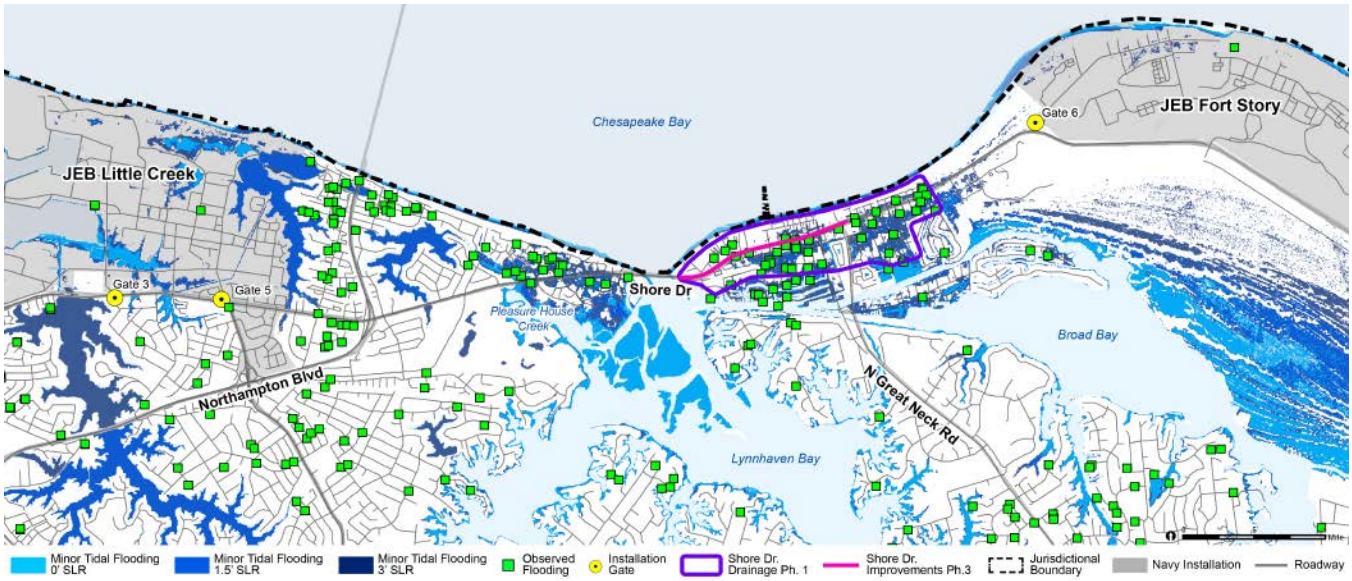


FIGURE 3-6: Action 2: Sea Level Rise Scenarios and Historical Flood Complaints

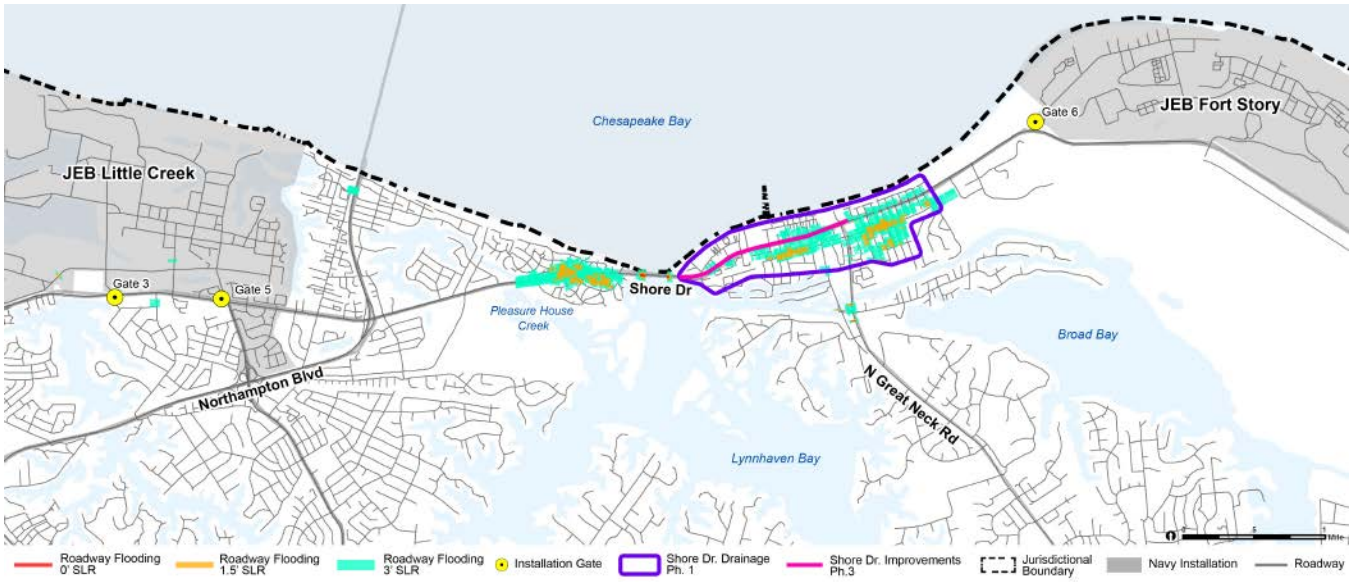


FIGURE 3-7: Action 2: Transportation Infrastructure Vulnerability

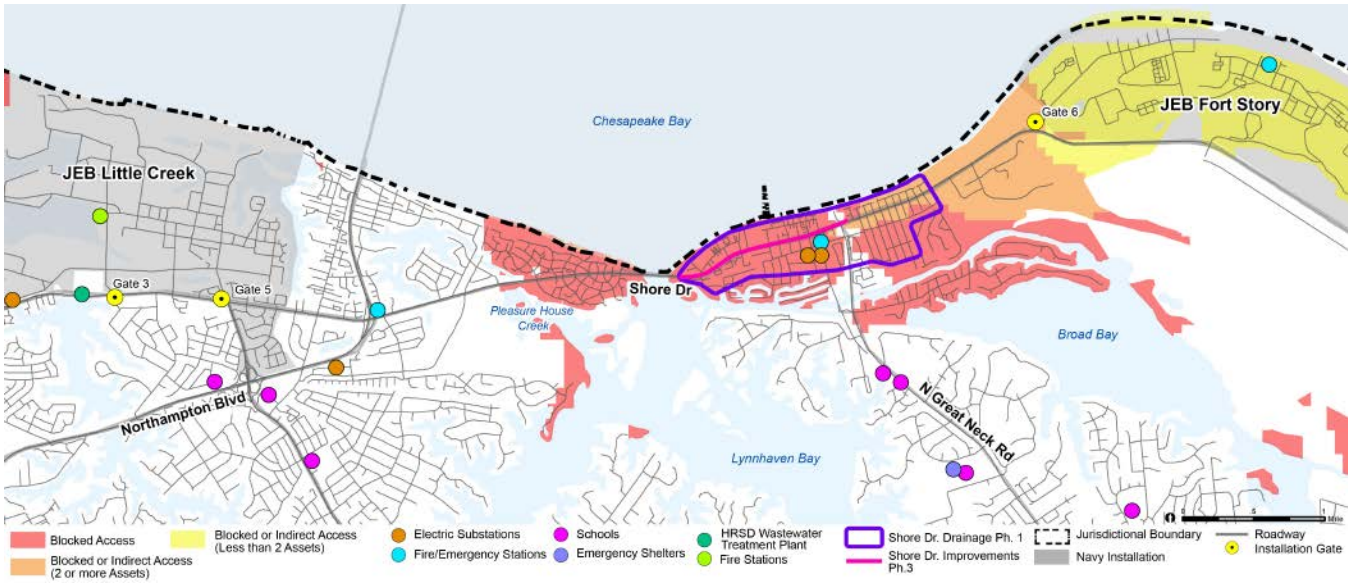


FIGURE 3-8: Action 2: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

Proposed Action

Virginia Beach has expended significant engineering study and design effort in the past several years to develop a quantitative understanding of flooding potential along the Shore Drive Corridor in various tidal conditions and precipitation events. The bulk of this effort has focused on the corridor east of the Lesner Bridge across Lynnhaven Inlet, starting as a drainage study, and eventually evolving into the multi-phase Eastern Shore Drive Drainage Improvements CIP projects.[1]

This Action recommends a comprehensive corridor study that leverages the work currently underway along the Eastern Shore Drive corridor, and expands upon it to address the western Shore Drive corridor using a similarly thorough study and conceptual design approach.

Virginia Beach's improvement projects for Eastern Shore Drive include a combination of short- and long-term solutions to address both tidal and precipitation flooding processes. Virginia Beach has already constructed three controllable sluice gates in the Cape Henry Ditch that are designed to prevent backflow in the ditch during minor to moderate tidal flooding events from flooding Shore Drive and adjacent residential areas. Detailed design of multiple projects is underway to upgrade older stormwater pumping stations, construct new pumping stations, and upgrade stormwater drainage infrastructure.

The attributes of Western Shore Drive appear to offer multiple opportunities to address tidal flooding with sea level rise and rainfall flooding through roadway improvements, drainage improvements, and backflow prevention at stormwater outfalls and the Pleasure House Creek crossing. These improvements could be aligned with other improvements already underway or being considered by the City, and the ongoing *Comprehensive Sea Level Rise and Recurrent Flooding Planning Study*.[2]

1 The sections previously known as Phase I & II of Virginia Beach's Eastern Shore Drive Drainage CIP projects have been incorporated in Phase I as Sections I and II, so Phase II is not shown on these maps, as it is not relevant to this area of Shore Drive.
2 City of Virginia Beach, "Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Planning Study: Policy

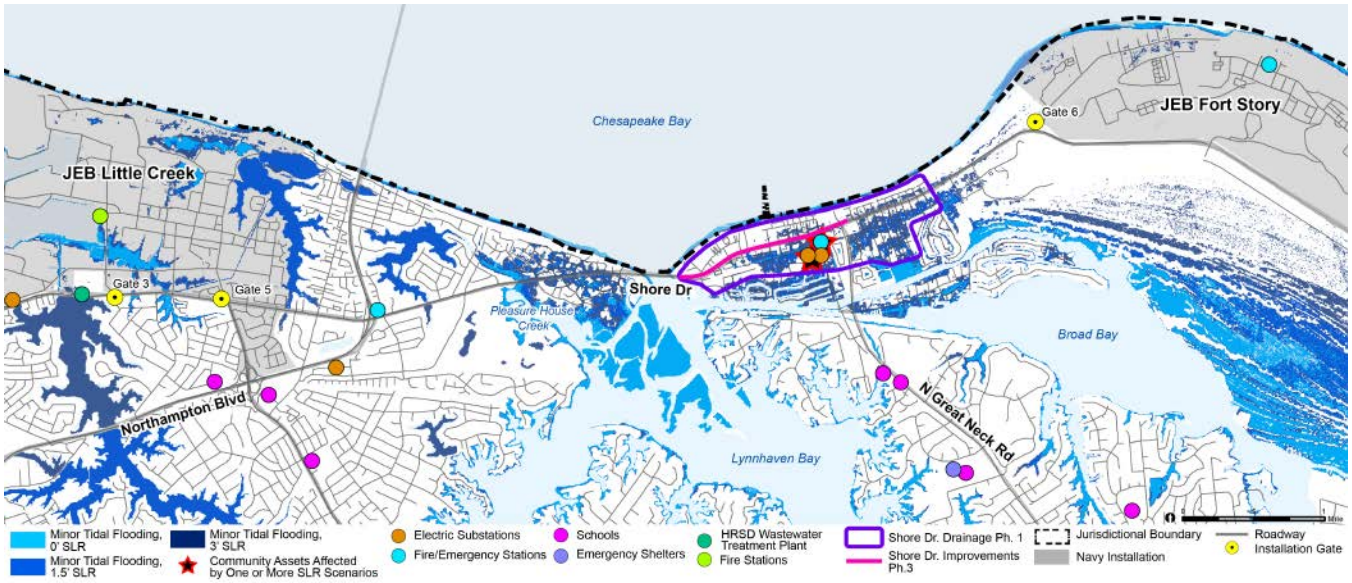


FIGURE 3-9: Action 2: Community Assets Vulnerability Analysis

The strategy should develop a range of options and identify a preferred approach for addressing the impacts of sea level rise. Elevating portions of Shore Drive west of the Lesner Bridge could help alleviate recurrent nuisance flooding, and would help protect the roadway in the event of additional sea level rise. However, this approach could also be very challenging due to the existing conditions and design of the roadway, the surrounding development, location of buried utilities, etc. Elevating portions of the corridor should be evaluated as part of the study.

Virginia Beach's *Stormwater Master Plan Update* and the *Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Planning Study* provide a starting point for pursuing this action and identifying preferred strategies to provide greater protection for Shore Drive from both precipitation and storm surge flooding, as well as the impacts of additional sea level rise.

Action Benefits

- Could identify opportunities to reduce both current and future flood risk along a primary corridor serving the DoD.
- Could identify opportunities to maintain access to JEB Fort Story, and the communities located along Shore Drive between both installations.
- Could identify opportunities to reduce current flood risk to the surrounding community and protect it from future sea level rise.
- Could result in strategies that improve access to community assets that DoD personnel rely upon, including fire/emergency stations and elementary schools that also serve as emergency shelters.
- Could present opportunities for incorporating green infrastructure elements and enhanced ecological benefits, if implemented as a comprehensive strategy.

Recommendations and City-wide Flood Protection Strategies." Presentation, Virginia Beach, VA, January 15, 2019. https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/slr-rf-plan-study-policy-strat-council-brief-1-15-19.pdf.

- Addresses future conditions, including additional sea level rise.

Implementation Steps

1. Using the *Comprehensive Sea Level Rise* study and *Master Drainage Plan* models and findings, evaluate specific strategies for maintaining comprehensive access along Shore Drive between JEB Little Creek and JEB Fort Story. It is expected that strategies would include infrastructure options such as:
    a. Improvements west of the Lesner along the western Shore Drive corridor through road surface elevation, drainage improvements, and backflow prevention at stormwater outfalls and the Pleasure House Creek crossing.
    b. Potentially, elevating portions of Shore Drive east of the Lesner Bridge, understanding that the evaluation of the need for doing so would be closely coordinated with ongoing pump station, tide gate, and storm drainage improvement projects.
3. Pursue funding for project design and engineering.

Other Actions along the Shore Drive corridor could be pursued in conjunction with this strategy, depending on available funding, staff resources, and interest. Nearby related actions include:

- Action #10: Pleasure House Point Flood Mitigation Strategy

Lead: Virginia Beach

Partners: U.S. Navy

Funding and Approval Status

- FY2018 funding has been authorized for the construction of Sections I and II (previously known as Phase I & II) of Virginia Beach's Eastern Shore Drive Drainage CIP projects. Preliminary engineering design is currently underway. Design efforts are also being coordinated with the Shore Drive Phase III.
- Funding for Phase IV is currently on hold.
- No official planning or design work has been initiated to undertake a more comprehensive study of the corridor as described in this Action, and no funding has been allocated for further study.

Cost Range

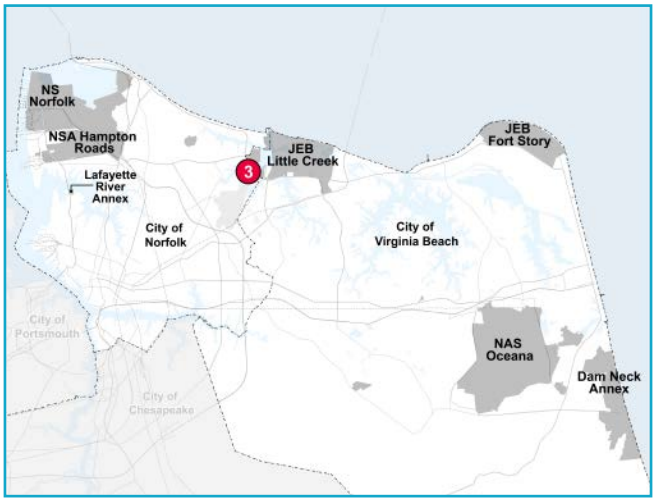
- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- Virginia's Transportation Funding (VDOT, DRPT)
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- U.S. DoD OEA Implementation Grants
- Federal Emergency Management Agency (FEMA) National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- FHWA National Highway Performance Program
- FHWA Defense Access Road Program

3.2.3 JEB Little Creek Gate 1 – Amphibious Drive – Shore Drive Flooding Study

3



This Action proposes undertaking a joint technical hydrologic and hydraulic (H&H) modeling study to determine causes of flooding on Shore Drive, near JEB Little Creek Gate 1, and Amphibious Drive, an internal on-base access route.

Action Score: 18

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **1**

System Performance and Design: **4**

Gate 1, located on Shore Drive in Norfolk, is a primary access point to JEB Little Creek. Currently, routine precipitation flooding around Gate 1 frequently causes congestion and delays for military personnel attempting to enter and exit the base. This issue can be compounded when recurrent flooding occurs on Amphibious Drive, the only internal roadway connecting the eastern and western sides of JEB Little Creek that roughly parallels Shore Drive. Shore Drive is a major east-west corridor connecting the cities of Norfolk and Virginia Beach, and is also the most direct route between JEB Little Creek and JEB Fort Story.

The Need for Action

During the JLUS process, concerns about flooding near Gate 1 on Shore Drive were raised. **Figure 3-10** shows the observed flooding reports in the vicinity, and the anticipated impact of sea level rise over time. According to base personnel, additional flooding occurs along Amphibious Drive, but is not depicted by the city data shown on the map.

Because recurrent flooding on Amphibious Drive is also an issue, base personnel rely upon Shore Drive to reach other areas of the base when access along Amphibious Drive is impeded. Recurrent roadway flooding can also compromise response times for emergency vehicles trying to access different parts of the base. When Shore Drive near Gate 1 is blocked or congested due to flooding, emergency vehicles may be required to take alternate routes to access the base and surrounding neighborhoods. Likewise,

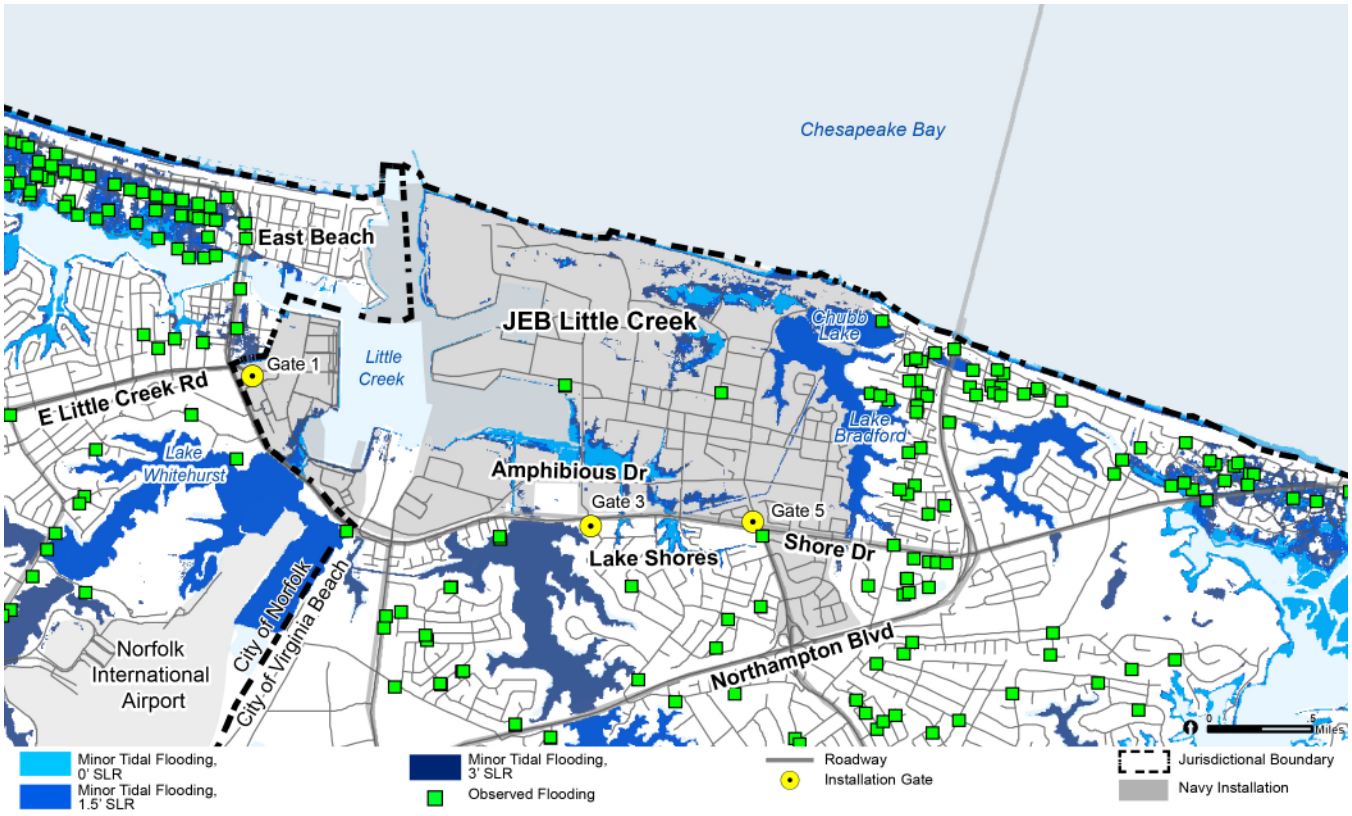


FIGURE 3-10: Action 3: Sea Level Rise Scenarios and Historical Flood Complaints

access to other community assets, like schools and emergency shelters, may be reduced for some neighborhoods in this area, such as East Beach. Therefore, continuous access along both Shore Drive and Amphibious Drive is critical for military readiness. **Figure 3-11** shows how long-term sea level rise could impact Shore Drive and Amphibious Drive over time. **Figure 3-12** shows how flooding could potentially affect access to nearby neighborhoods during minor tidal flooding plus 3.0 feet of SLR.

Shore Drive also experiences flooding in precipitation events, which could compound tidal flooding impacts in the sea level rise scenarios evaluated. If both Amphibious Drive and segments of Shore Drive local to JEB Little Creek were to flood at the same time, vehicular access from one side of JEB Little Creek to the other would be cut off for the duration of the flooding event. A detailed H&H model and study would be needed to clearly understand how precipitation events and/or tidal events cause flooding in this area.

Proposed Action

This Action recommends an H&H study to identify the processes that cause flooding both on Shore Drive (along the entire length of JEB Little Creek) and along Amphibious Drive within JEB Little Creek. It is recommended that the H&H study be conducted jointly between Virginia Beach, Norfolk, and the Navy to ensure that the best available data on relevant infrastructure, tidal conditions, and precipitation events are included in the study.

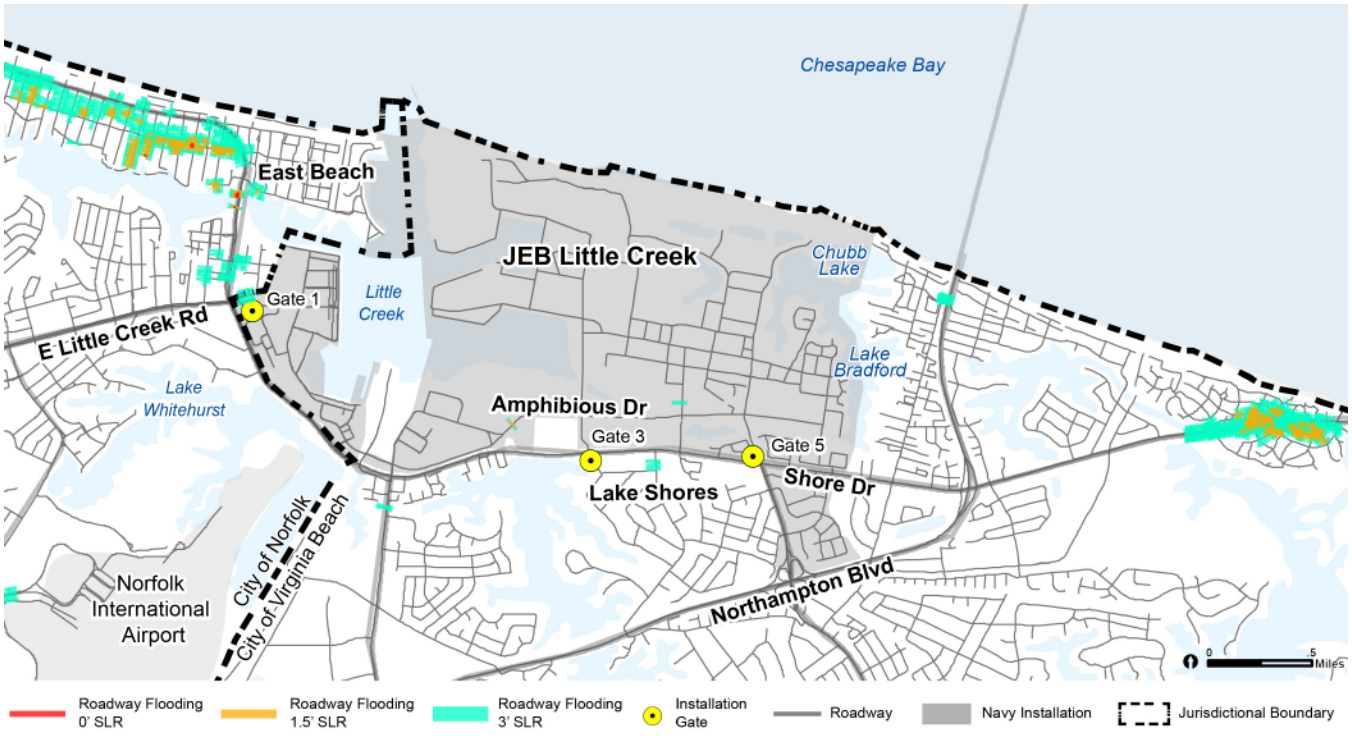


FIGURE 3-11: Action 3: Transportation Infrastructure Vulnerability

The H&H study is needed because there is not currently enough information available to determine the direct causes of the roadway flooding at the various reported recurrent flooding locations. The processes currently causing flooding along Amphibious Drive are most likely a combination of tidal flooding from the Chesapeake Bay through Little Creek Inlet, and precipitation flooding related to the capacity of existing inlets, pipes, and culverts to drain stormwater to Little Creek Harbor. The study should include the interactions of Lake Bradford, Chubb Lake, and Lake Whitehurst with Shore Drive, Amphibious Drive, and Little Creek Harbor, as well as the tidal and storm surge effects from the Chesapeake Bay. The long-term impacts from sea level rise could also affect the area around Lake Whitehurst and Shore Drive. The causes of flooding at one point may well be different than the causes of flooding at other locations within this study area. A joint technical H&H study would help to locate and quantify the causes of flooding at different points along the roadways, which would then facilitate the identification and design of infrastructure and management solutions to address recurrent present flooding and potential future flooding related to sea level rise.

The proposed study should use the recently developed Virginia Beach *Stormwater Master Plan Update* models as a baseline. It is also recommended that the Pretty Lake watershed stormwater models that Norfolk completed in 2011 are updated as part of this effort, to ensure the data reflects more recent development in the area. Additionally, any changes to the drainage basins, the Pretty Lake watershed, and Lake Whitehurst that would occur related to the

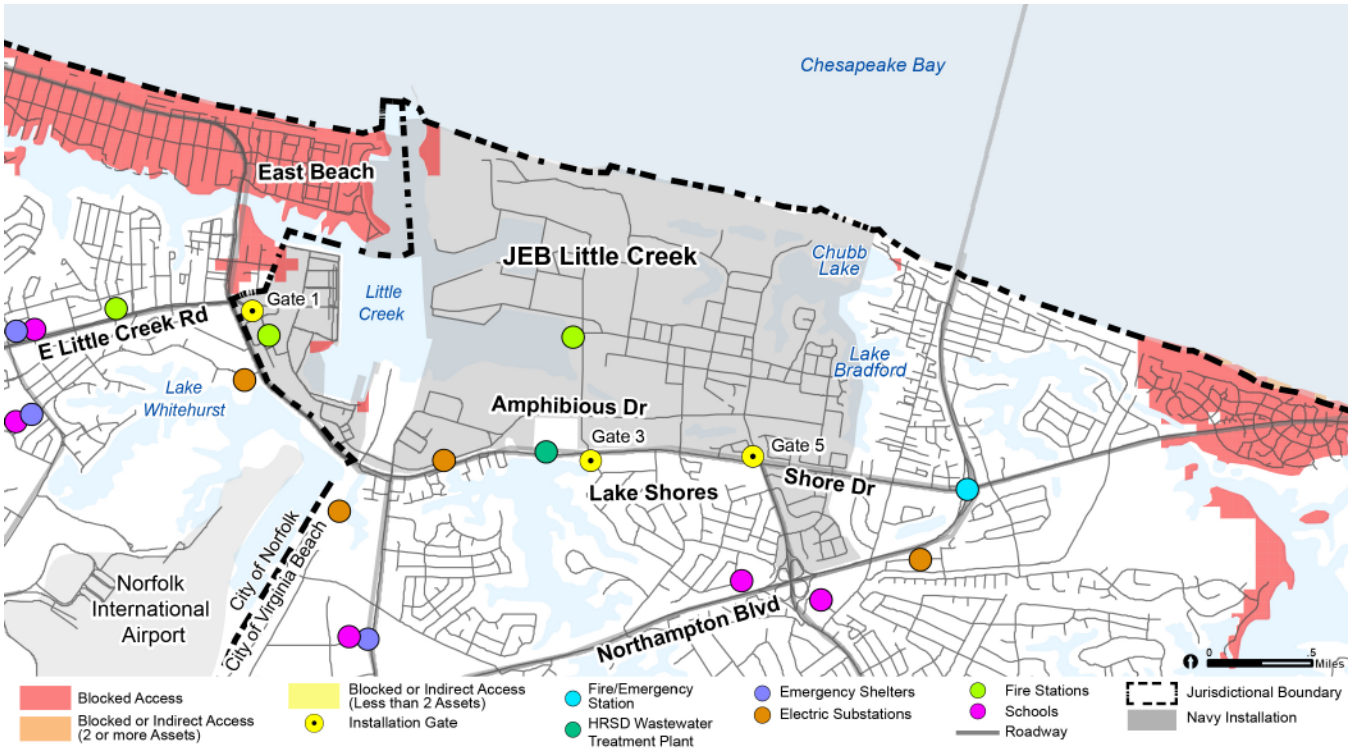


FIGURE 3-12: Action 3: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

proposed expansion project at Norfolk International Airport (ORF) should be considered in the proposed study.

The recommended H&H study findings should be utilized to inform the development of design solutions that will effectively manage stormwater and drainage around Gate 1, along this portion of the Shore Drive corridor, and along Amphibious Drive internal to the base. Project design should also account for the potential impacts of additional sea level rise. This Action would require coordination and sharing of data among technical staff from Norfolk, Virginia Beach, the USACE, and the Navy.

This Action is located adjacent to the proposed Pretty Lake Storm Surge Barrier (Action #8), which is recommended as part of the 2018 *City of Norfolk USACE CSRM Feasibility Study*. It is not fully understood how the proposed surge barrier would or could influence current and future flood concerns around Gate 1 and along Amphibious Drive. The Navy has expressed concern about the Pretty Lake Storm Surge Barrier as it relates to navigational needs, and has requested that the USACE pursue sediment transport modeling during future phases of the project. A more complete description of the project and the Navy's full list of concerns is included in Action #8. Therefore, as the USACE Pretty Lake Storm Surge Barrier project progresses, and Action #3 is pursued, it is recommended that the project partners work together to incorporate the additional hydrologic, hydraulic, sediment, and coastal modeling calculations and design efforts of both projects, to provide a comprehensive and appropriate solution.

Action Benefits

- Could result in strategies to significantly reduce both current and future flood risk along portions of Shore Drive, a strategic corridor serving both the JEB Little Creek, and Amphibious Drive, a critical internal base access road.
- Could result in stormwater management and flood mitigation strategies to reduce roadway flooding and improve access to both JEB Little Creek installations for personnel residing in both Norfolk and Virginia Beach.
- Could result in strategies that improve access to community facilities that both DoD personnel and civilians rely upon, such as fire and emergency response stations and elementary schools/ emergency shelters, as well as improve the ability of emergency vehicles to access areas internal to the installation.
- Could result in strategies that reduce current flood risk to the surrounding neighborhoods and potentially mitigate some of the impacts of increased sea level rise in the future.
- Could present opportunities for incorporating green infrastructure elements into the ultimate stormwater management/flood risk mitigation design solution which could potentially provide greater ecological benefits.

Implementation Steps

1. Create a working partnership between Norfolk, Virginia Beach, the Navy, and the USACE to coordinate and oversee the study.
2. Determine the scope for work for the study and pursue funding.

Update the existing watershed models developed for the Pretty Lake watershed (2011), and utilize the Virginia Beach *Stormwater Master Plan Update* (ongoing) and all other existing studies, watershed and drainage basin models, and other planning and/or design work done for this area as a baseline.

3. As an input to the H&H study, undertake a field survey of known areas where flooding has historically occurred on Amphibious Drive. The survey should include a detailed survey of the stormwater system draining Amphibious Drive and Shore Drive in this vicinity.
4. Jointly determine preferred design solutions to address flooding based on study outcomes.
5. Identify phasing and jointly pursue funding for implementation of the preferred design solution.
6. Define applicable operating and maintenance parameters as part of any solution.

Lead: Norfolk, Virginia Beach

Partners: U.S. Navy, USACE, Norfolk International Airport

Funding and Approval Status

Although studies and models exist for this area, no official study or planning work has been initiated for this Action. Norfolk and Virginia Beach should determine if ongoing studies can be updated or modified to address this Action. Funding sources for this specific study have not been identified.

Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

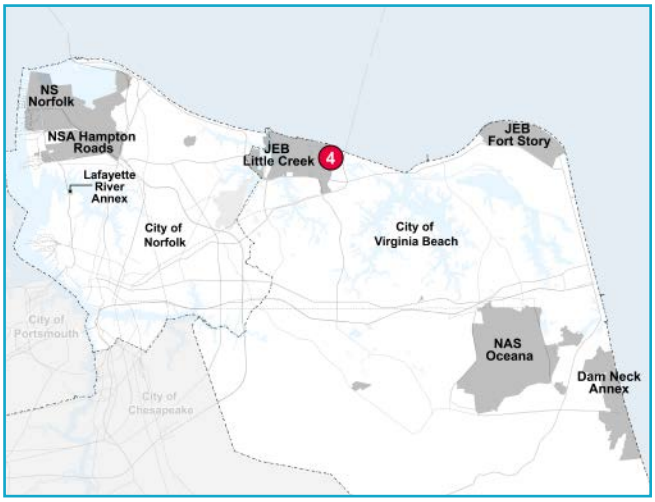
Potential Funding Sources

- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund

- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- U.S. DoD OEA Implementation Grants
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- FHWA Defense Access Road Program

3.2.4 East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy

4



This Action proposes the development of a comprehensive strategy for mitigating flooding along East Amphibious Drive on JEB Little Creek and surrounding areas.

Action Score: 17

Installation Readiness: **6**

DoD Personnel Readiness: **4**

Co-Benefits: **3**

System Performance and Design: **4**

The eastern segment of Amphibious Drive, just south of Lake Bradford and Chubb Lake, is the main internal roadway connecting the eastern and western sides of JEB Little Creek. Tidal flooding creates significant internal access challenges along the corridor.

The Need for Action

Tidal and storm events, combined with aging stormwater management infrastructure both on and off JEB Little Creek, regularly impact the areas south of Lake Bradford and Chubb Lake. The lakes, located east of JEB Little Creek are connected and influenced by tides in the Chesapeake Bay to the north. The Virginia Beach and Navy stormwater management systems that manage the flow are interconnected and both are impacted by present tidal conditions.

JEB Little Creek is at the receiving end of a large drainage area that includes several neighborhoods outside the installation. The off-base drainage typically travels from Lake Bradford and Chubb Lake through an on-base drainage channel near the base's Boone Clinic. From here, drainage makes its way through a control point to Little Creek Cove. Tidal flooding from Little Creek Cove can push eastward, back toward the Boone Clinic.

Historical flood complaint data from Norfolk and Virginia Beach have documented multiple flood complaints just outside the JEB Little Creek fenceline along Shore Drive, as shown in **Figure 3-13**. Navy personnel have reported additional flooding on base, particularly along Amphibious Drive, and in the parking lot adjacent to Boone Clinic. Because it is a

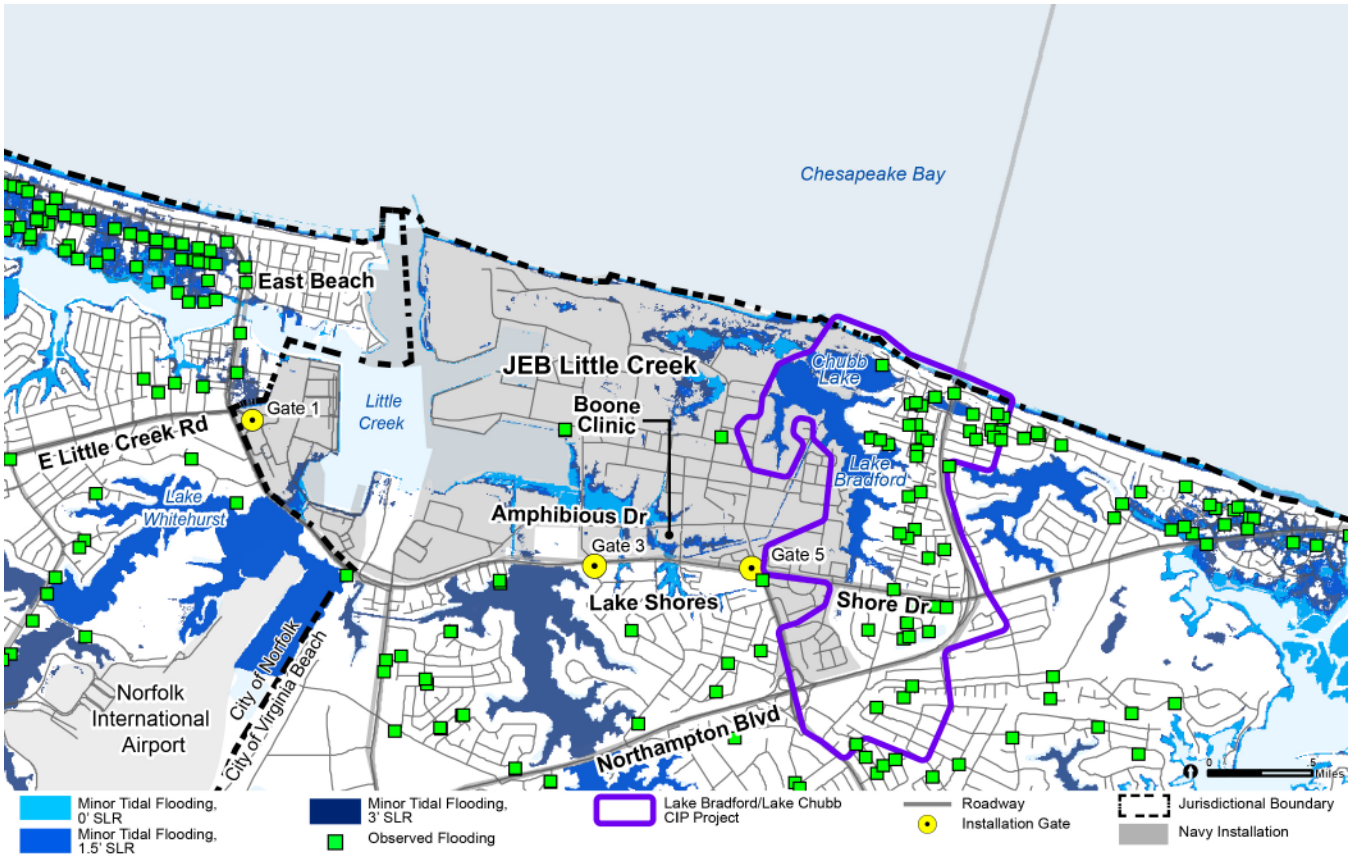


FIGURE 3-13: Action 4: Sea Level Rise Scenarios and Historical Flood Complaints

main internal east-west access route on the base, flooding on Amphibious Drive can make it difficult for Navy personnel to access different parts of the installation, sometimes forcing them to exit the base and use Shore Drive as an alternate route. If there is simultaneous flooding on Shore Drive, vehicular access from one side of the JEB Little Creek base to the other would be cut off for the duration of the flooding event.

Sea level rise will result in more frequent direct flooding of Amphibious Drive and Shore Drive by tidal and storm surge flooding, and it will exacerbate existing precipitation flooding challenges by inhibiting drainage through channels that outfall to Little Creek Harbor.

Tidal and precipitation flooding could also impact access for portions of the neighborhoods surrounding the installation, which are home to DoD personnel and their families. Roadway flooding could impact access to critical community facilities or emergency services. Areas that could experience blocked access under a 3.0-foot SLR scenario are shown in **Figure 3-14**.

Proposed Action

Preliminary engineering design is currently underway for the Lake Bradford/Chubb Lake Virginia Beach CIP project (Project Reference #7.053.000). The CIP project will design and construct stormwater and roadway improvements to alleviate flooding caused by moderate rain and tide events in Lake Bradford and

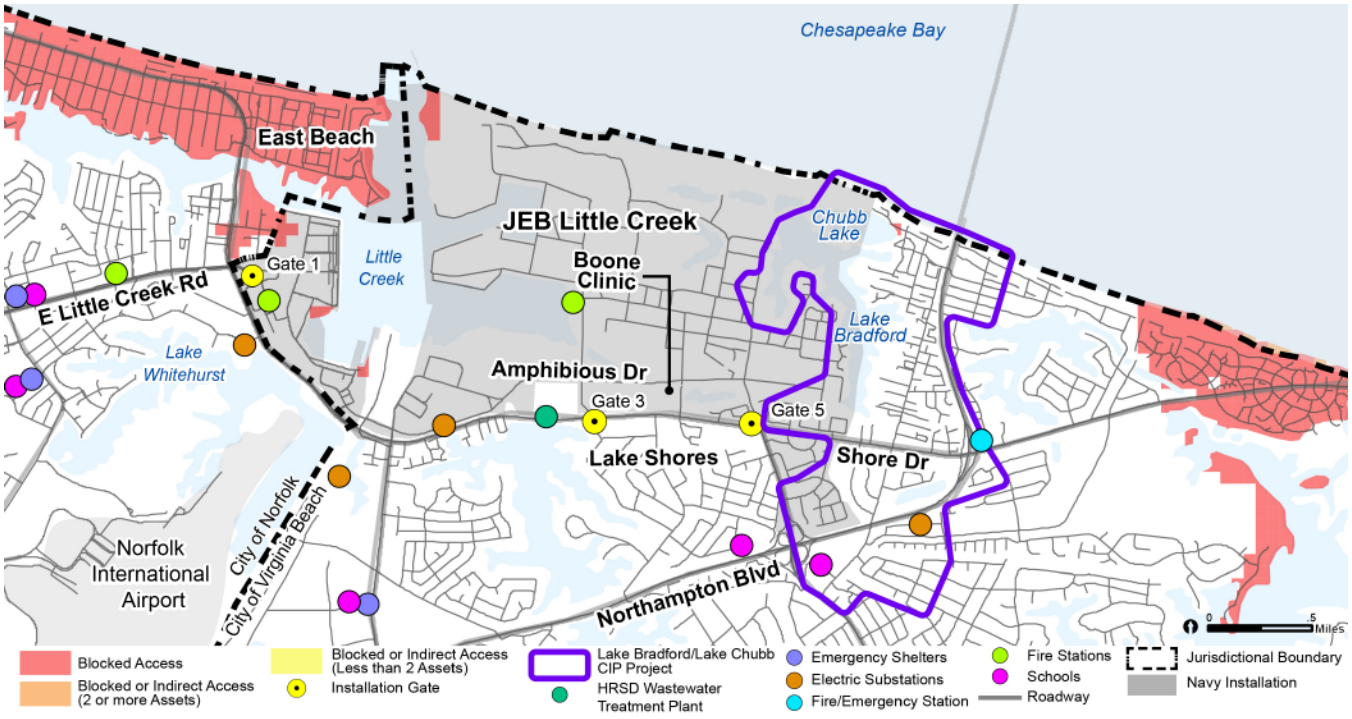


FIGURE 3-14: Action 4: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

Chubb Lake. In addition to the CIP project, this Action recommends developing a more comprehensive strategy for mitigating flooding along East Amphibious Drive and the surrounding areas in order to help alleviate flooding that is occurring on JEB Little Creek.

The drainage improvements that Virginia Beach is considering include storm drain pipe improvements, additional stormwater culverts, additional tide gates, stormwater management pond improvements, and channel/ditch clearing improvements. In addition to these CIP improvements, this Action proposes establishing an easement that could allow Virginia Beach to manage and maintain the drainage ditch/ channel that conveys stormwater between the city and the JEB Little Creek. This channel flows inland, through JEB Little Creek to Little Creek Harbor.

This Action also recommends evaluating the potential for a tide gate at Helicopter Road, in combination with the existing weir gate, to manage tidal water levels and stormwater discharges to increase flooding resilience in this low-lying part of JEB Little Creek. The tide gate system could be enhanced by the installation of a pumping station to help actively manage water levels in the lakes and channels. Chapter 5, Model Projects, discusses these design concepts in more detail, including additional detailed implementation steps and potential rough order of magnitude (ROM) costs.

Additional opportunities to reroute drainage along the southern edge of Shore Drive and the Lake Shores neighborhood (which drains onto the JEB Little Creek, near Gate 3) should also be evaluated as part of this action. Virginia Beach has been working with the Navy to map on-base drainage patterns as part of this study, and is currently working on incorporating this information into the Drainage Basin 1 and 31 model.[1]

1 Per CJ Bodnar with the City of Virginia Beach Stormwater Engineering Center, 3/26/2019

Other Actions near this area could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest. Nearby related Actions include:

- Action #3: JEB Little Creek Gate 1 and Shore Drive Flooding Study
- Action #2: Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy

Action Benefits

- Could identify strategies to reduce both current and future flood risk to a strategic on-base access route (Amphibious Drive) and an on-base medical facility (Boone Clinic).
- Could identify strategies to reduce current flood risk to the surrounding community, as well as protecting it from some of the impacts of future sea level rise.
- Could identify strategies to improve access to community assets that both DoD personnel and civilians rely on, such as schools/emergency shelters and fire stations.
- As proposed, Action considers future conditions, including additional sea level rise.

Implementation Steps

Preliminary engineering design is currently underway for the Lake Bradford/Chubb Lake Virginia Beach CIP project, and this action could be coordinated with that broader design effort. Recommended additional implementation steps include:

1. Create a working partnership between Virginia Beach and the Navy to determine the best vehicle (existing CIP project or new study) for preparing a comprehensive study.
2. Use the existing Virginia Beach watershed models to evaluate the use of tide gates at Helicopter Road, plus additional steps including pumping and channel dredging with active lake management, for improving flooding resilience in this action area.
3. Jointly determine preferred design solutions to meet Navy and City goals.
4. Identify phasing and jointly pursue funding for project implementation.
5. Define applicable operating and maintenance parameters as part of any solution.

Lead: Virginia Beach

Partners: U.S. Navy

Funding and Approval Status

Preliminary engineering design for the Virginia Beach CIP project is currently underway and funding for design has been appropriated. The CIP project could potentially be modified to address the requirements of this action. Additional funding would be required for recommended modifications, but is not yet in place.

Cost Range

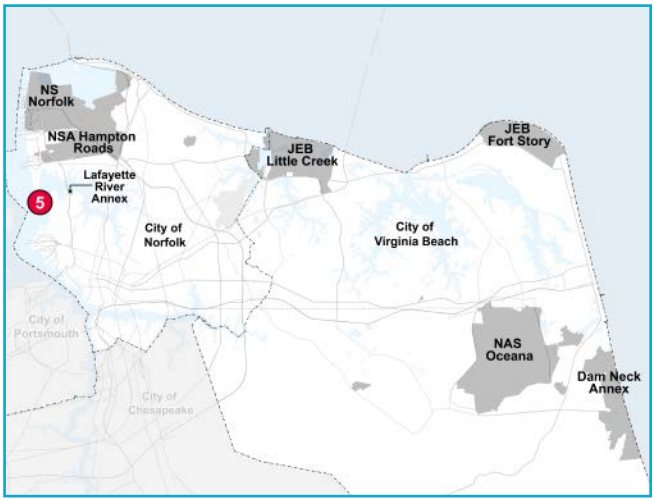
- $$$$ ($10M – $25M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- U.S. DoD OEA Implementation Grants
- NOAA Coastal and Estuarine Land Conservation Program

- NOAA Coastal Resilience Grants
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- U.S. EPA Clean Water State Revolving Fund
- U.S. Fish and Wildlife Service (USFWS) North America Wetlands Conservation Act 2019-2 U.S. Standard Grants

3.2.5 Lafayette River Outer Surge Barrier (USACE) 5



This Action recommends implementing the USACE CSRM study recommendation for an outer surge barrier on the Lafayette River.

Action Score: 16

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **1**

System Performance and Design: **2**

The Lafayette River separates the northwestern half of Norfolk, which includes the NS Norfolk and NSA Hampton Roads installations and Norfolk International Terminals, from the southwestern portion of the city, which is home to the Lafayette River Annex and the city's downtown. The Lafayette River flows directly into the Elizabeth River, a major shipping channel, which feeds directly to the Chesapeake Bay.

The Need for Action

Flooding from the Lafayette River during tidal and storm events is a recurring issue in the adjacent neighborhoods and along nearby roadways, including along Hampton Boulevard, a primary corridor serving NS Norfolk, NSA Hampton Roads, and Lafayette River Annex. This is documented by the number of roadway flooding complaints that Norfolk has received over the past 9 years, shown in **Figure 3-15**. Hampton Boulevard is a major north-south route for military personnel and civilians who live and work in Norfolk and other parts of the region.

As sea levels rise and flooding along this corridor worsens, neighborhoods on either side of Hampton Boulevard and Hampton Boulevard Bridge could experience reduced access to community facilities. This condition is illustrated in **Figure 3-16**, which shows access impacts under a 3.0-foot SLR scenario.

Proposed Action

The 2018 *Final Integrated City of Norfolk USACE CSRM Feasibility Study* proposes implementing a storm surge barrier on the Lafayette River, from NIT to

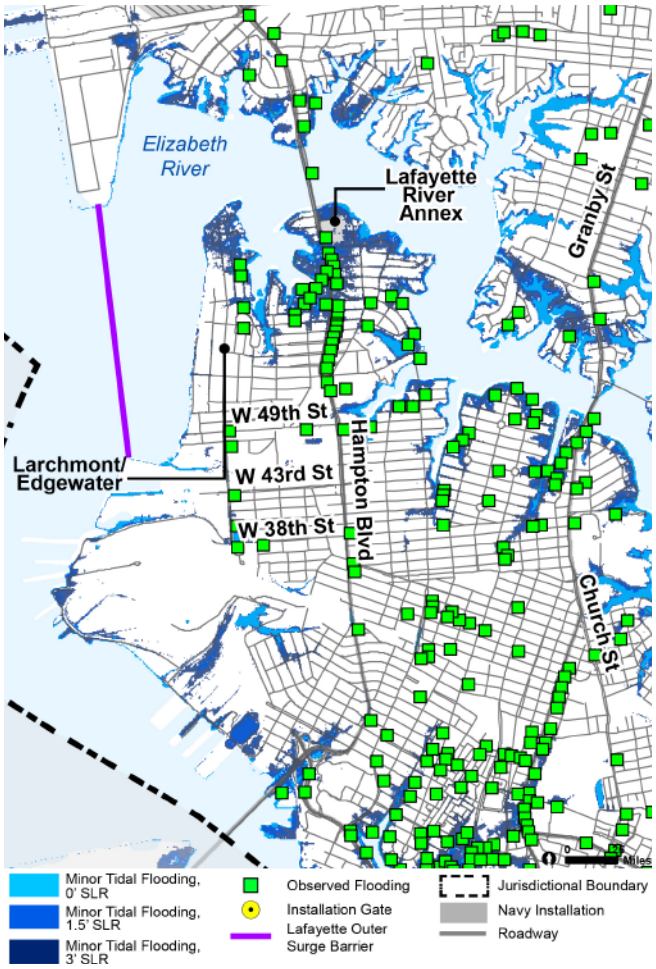


FIGURE 3-15: Action 5: Sea Level Rise Scenarios and Historical Flood Complaints

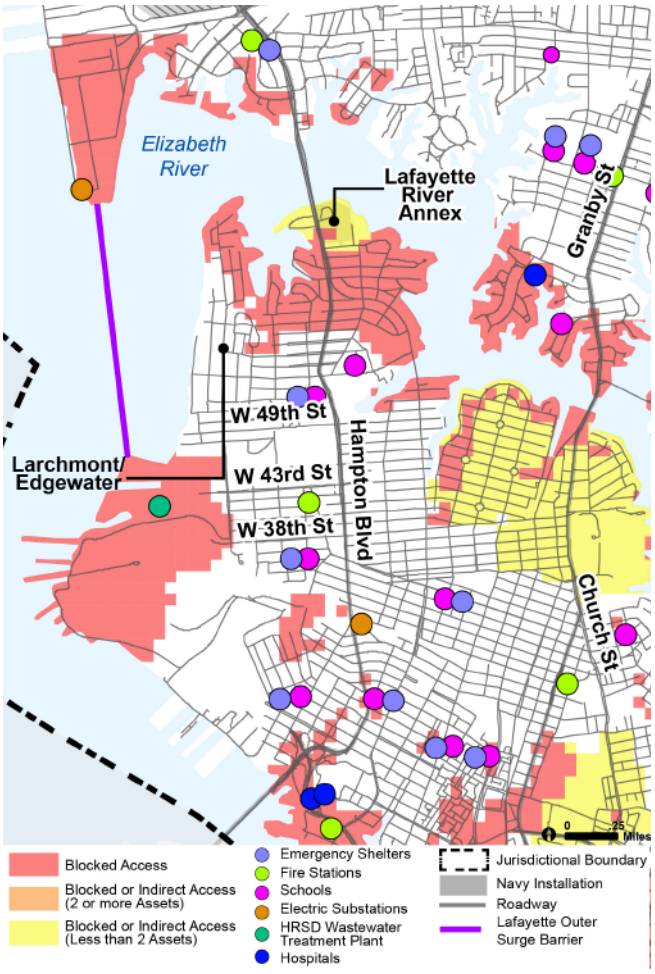


FIGURE 3-16: Action 5: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

the Lambert's Point Golf course, as a way to manage flood risk to the Lafayette River watershed. The proposed project location is shown on all maps for this Action.

According to the study, the barrier would protect the portions of Hampton Boulevard currently at risk for flooding. Along with the barrier, USACE is proposing to implement additional nonstructural floodproofing measures for the industrial areas west of the proposed barrier, as well as installing a "living shoreline," conducting wetlands mitigation, and installing an oyster reef adjacent to the barrier.

The proposed storm surge barrier would not, by itself, mitigate rainfall flooding, except to the extent that closing the barrier on a low tide before a high tide/ surge event would allow for additional stormwater receiving capacity in the river. However, this proposed action would greatly reduce flood risk to parts of Hampton Boulevard, as well as adjacent neighborhoods, from tidal/storm surge flooding. This would help ensure that Hampton Boulevard remained a passable, efficient means of access for all those using the corridor, including military personnel.

Action Benefits

- Could reduce both current and future flood risk to storm surge flooding for the Lafayette River Annex.
- Could significantly reduce both current and future flood risk along a portion of Hampton Boulevard, a strategic corridor serving the DoD.
- Could reduce current flood risk to the surrounding Larchmont/Edgewater neighborhood and protect it from some of the impacts of increased sea level rise in the future.
- Could improve access to nearby community facilities that DoD personnel and civilians rely upon.
- Considers future conditions, including additional sea level rise.

Implementation Steps

1. Coordinate with the Virginia Port Authority, U.S. Coast Guard, Virginia Marine Resources Commission, and other navigation- and environment-related stakeholders in the Lafayette River. This will be critical in order to design and construct the project in a way that minimizes adverse impacts to existing functions of the river and the landward tie-in points.
2. Norfolk and USACE should work together to identify phasing, and jointly pursue funding for project design and implementation.
3. Define applicable operating and maintenance parameters as part of any solution.

Other Actions in this area could be influenced by implementing the surge barrier infrastructure project, including those along Hampton Boulevard. These other efforts should consider integrating the surge barrier as part of any design concept and alternatives process to understand how it could impact outcomes. Nearby related Actions include:

- Action #19: Lafayette River Annex Vulnerability Study
- Action #1: Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy

Lead: Norfolk

Partners: USACE, Virgina Port Authority

Funding and Approval Status

The *Final Integrated City of Norfolk USACE CSRM Feasibility Study* has been completed and submitted to Congress, including early stage preliminary design of this action's infrastructure elements, and this action is included as a recommended measure within the overall CSRM plan. Preconstruction Engineering and Design (PED) funding has been allocated in the current fiscal year. However, the currently-allocated PED funds are for a different segment of the overall Norfolk project area.

Cost Range

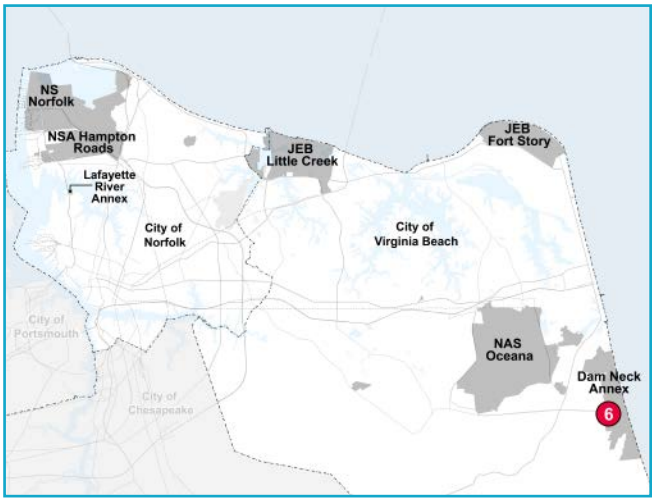
- $$$$$ (> $50M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- U.S. DoD Community Infrastructure Program
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- USACE Section 205: Flood Risk Management Program
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water State Revolving Fund
- USFWS North America Wetlands Conservation Act 2019-2 U.S. Standard Grants

3.2.6 Dam Neck Gate Flood Impact Study

6



This Action recommends an H&H study to evaluate drainage conditions around the Dam Neck Annex Main Gate.

Action Score: 15

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **0**

System Performance and Design: **2**

The main entry gate to Dam Neck Annex is located at the terminus of Dam Neck Road. The Main Gate is more directly accessible and heavily used than the South Gate, and connects to several routes serving the DoD, such as Princess Anne Road and I-264. This corridor as a whole provides direct connections to area installations and important community facilities.

The Need for Action

Although Dam Neck has not yet experienced serious recurring flood impacts to the Main Gate, the Main Gate could be impacted by minor tidal flooding under both the 1.5- and 3.0-foot sea level rise scenarios, as shown in **Figure 3-17**.

Impeded or blocked access to the installation's Main Gate would have a significant impact on for military readiness; the only alternative gate is located in an area that requires significantly longer driving time and is also vulnerable to tidal/rainfall flooding under both the 1.5- and 3.0-foot sea level rise scenarios.

Additionally, flooding on Dam Neck Road could impede access to community assets and facilities, such as fire stations, and elementary schools/ emergency shelters, particularly under a 3.0-foot SLR scenario, as shown in **Figure 3-18**.

Proposed Action

Studying the potential flood impacts of additional sea level rise on tidal flooding on the roadway near Dam Neck's Main Gate would allow the installation and Virginia Beach to jointly take adequate measures to

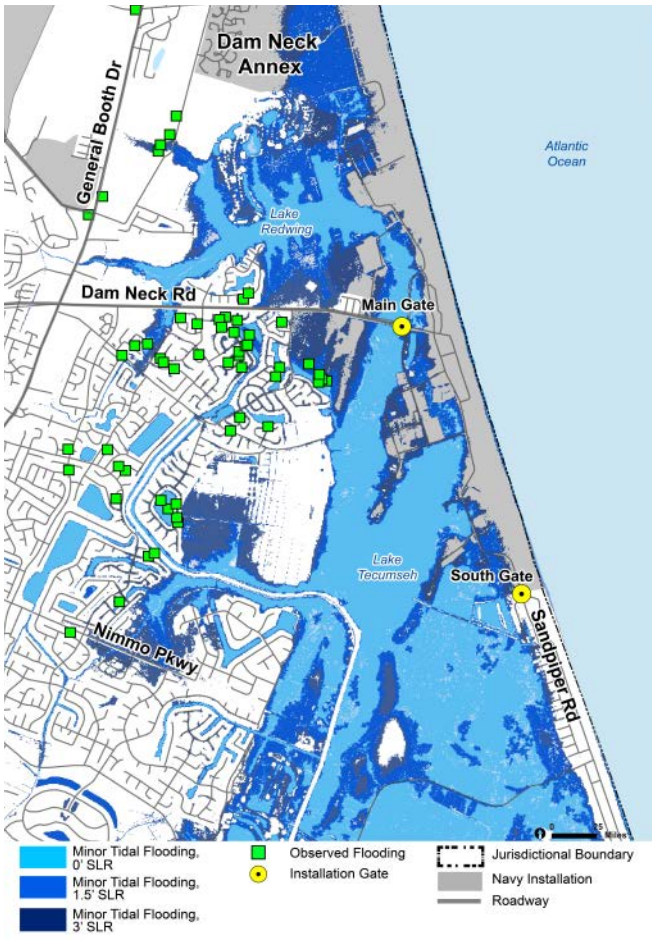


FIGURE 3-17: Action 6: Sea Level Rise Scenarios and Historical Flood Complaints

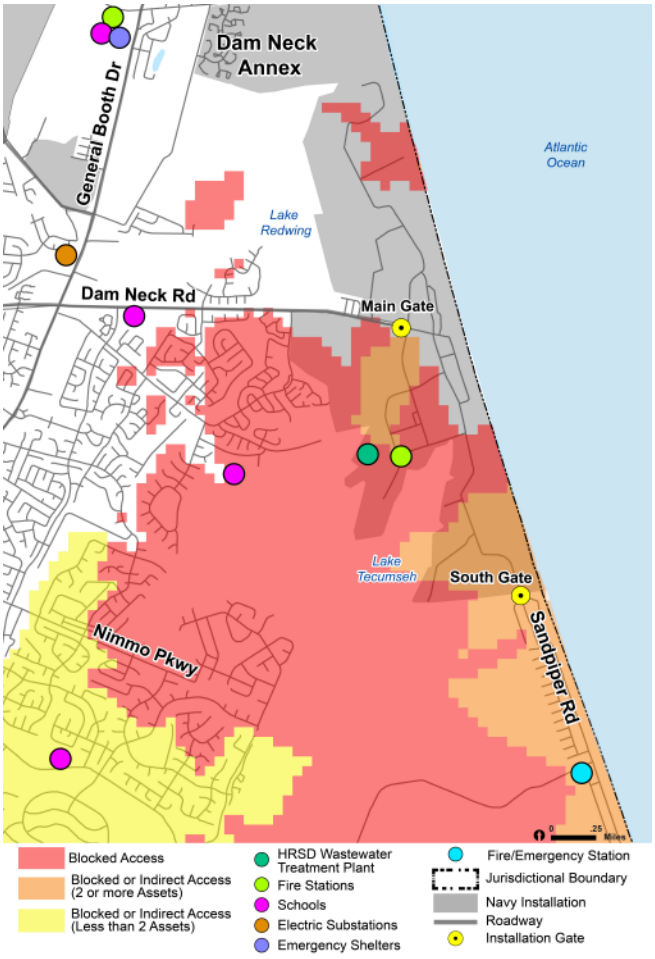


FIGURE 3-18: Action 6: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

ensure that access to this gate is not impeded or blocked due to flooding from tidal/storm events in the future.

This Action proposes undertaking an H&H study to evaluate the drainage conditions at the Dam Neck Annex Main Gate on Dam Neck Road in order to determine the existing drainage patterns and potential vulnerability to flooding, now and in the future.

It is recommended that, if not already readily available, a field survey of the stormwater system and road grades that drain to or from the Main Gate area and approaching segments of Dam Neck Road be conducted as part of this study. Virginia Beach's *Stormwater Master Plan Update* models should be used as a starting point. Any study done as part of this proposed action would be an opportunity to add detail to the current model.

This Action would require significant coordination between technical staff from Virginia Beach and the Navy, to inform the study and determine how best to

use the information gained from the study to plan, design, and implement a solution. Coordinating with Navy operations staff to ensure that the solutions will not generate other non-flooding related adverse impacts to the installation should be a critical part of the process.

Action Benefits

- Identifies potential opportunities to reduce flood risk on Dam Neck Road, a strategic corridor serving the DoD and important community access corridor.
- Identifies potential opportunities to mitigate flood impacts to the Dam Neck Annex Main Gate.
- Identifies potential opportunities to improve access to community assets along Dam Neck Road, now and in the future, including a fire station and elementary schools that also serve as emergency shelters.
- Could create opportunities for green infrastructure or other public roadway improvements.
- Addresses future conditions, including additional sea level rise.

Implementation Steps

1. Form a working partnership between Virginia Beach and the Navy to coordinate and oversee the study.
2. Define the scope of work for the study and pursue funding for study.
3. Utilize all existing studies, drainage basin models, and other planning and/or design work done for this area as a baseline for this study.
4. Conduct a field survey if not already available.
5. Once causes of flooding are determined, jointly determine preferred design solutions to address flooding.
6. Identify phasing and jointly pursue funding for project implementation.
7. Define applicable operating and maintenance parameters as part of any solution.

Lead: Virginia Beach

Partner: U.S. Navy

Funding and Approval Status

No study has been initiated for this action and no funding is currently in place for the study.

Cost Range

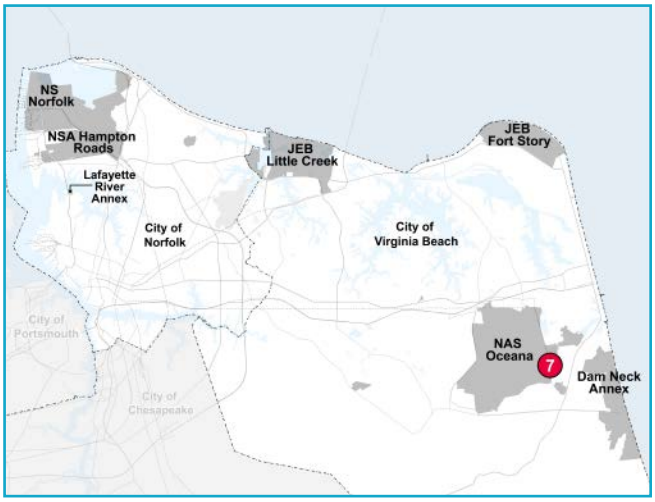
- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- U.S. Navy Funding
- U.S. DoD OEA Implementation Grants
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- FHWA Defense Access Road Program

3.2.7 Oceana Boulevard/Bells Road Drainage Study

7



This Action proposes undertaking an H&H study to evaluate the drainage conditions along Oceana Boulevard near the Bells Road gate.

Action Score: 15

Installation Readiness: **9**

DoD Personnel Readiness: **4**

Co-Benefits: **0**

System Performance and Design: **2**

NAS Oceana's Bells Road Gate, located on the eastern side of the installation at the intersection of Bells Road and Oceana Boulevard, is a heavily used entrance to the installation.

The Need for Action

The installation currently experiences issues with ponding and standing water at the Bells Road gate (Gate 1), which can cause traffic congestion or delays getting onto the installation. The cause of the ponding or standing water on the roadway has not yet been evaluated, although it is most likely related to the capacity of the current stormwater infrastructure.

Although the ponding is not normally deep enough to block access to the gate, a significant storm event may cause additional flooding in this location, which would impact the ability of NAS Oceana personnel to report for duty in a timely manner.

Proposed Action

This Action proposes undertaking an H&H study along Oceana Boulevard near the Bells Road gate in order to determine the cause of the ponding and standing water, and to identify solutions to address it. **Figure 3-19** identifies the location for this action.

It is recommended that a field survey of the stormwater system and road grades that drain to or from the flooding area be conducted as part of this study, if such data is not already available. Virginia Beach's *Stormwater Master Plan Update* models should be used as a starting point to evaluate the

FIGURE 3-19: Action 7: Approximate Action Location

causes of the observed flooding. Any study done as part of this proposed Action would be an opportunity to add detail to the current model.

This Action would require significant coordination between technical staff from Virginia Beach and the Navy, to determine how best to use the information gained from the study to plan, design, and implement a solution to the flooding issues at the Bells Road Gate. Coordinating with Navy operations staff will ensure that the solutions do not generate other non-flooding related adverse impacts to the installation.

Action Benefits

- Identifies opportunities to reduce flood risk on Oceana Boulevard, a strategic corridor serving the military and important access corridor for the base.
- Identifies opportunities for reducing impacts to NAS Oceana's Gate 1, an important installation asset.
- Identifies opportunities to reduce flood risk to Oceana Boulevard, which could benefit residents who use the roadway in addition to DoD personnel.
- Proposed Action considers future conditions, including additional sea level rise.

Implementation Steps

1. Form a working partnership between Virginia Beach and the Navy to coordinate and oversee the study.
2. Pursue funding for study.
3. Utilize all existing studies, drainage basin models, and other planning and/or design work done for this area as a baseline for this study.
4. Once causes of flooding are determined, jointly determine preferred design solutions to address flooding.
5. Identify phasing and jointly pursue funding for project implementation.
6. Define applicable operating and maintenance parameters as part of any solution.

Lead: Virginia Beach

Partners: U.S. Navy

Funding and Approval Status

No study has been initiated for this action and no funding is currently in place for the study.

Cost Range

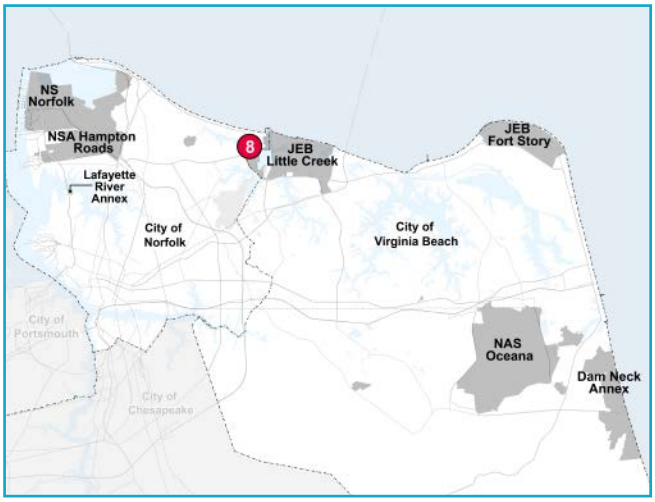
- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. Navy Funding
- U.S. DoD OEA Implementation Grants
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- FHWA Defense Access Road Program

3.2.8 Pretty Lake Storm Surge Barrier (USACE)

8



This Action recommends implementing the USACE CSRM study recommendation for an outer surge barrier on Pretty Lake.

Action Score: 15

Installation Readiness: **6**

DoD Personnel Readiness: **4**

Co-Benefits: **2**

System Performance and Design: **3**

Pretty Lake, a tidal water body connected to Little Creek Harbor, lies immediately to the west of the JEB Little Creek, and is connected to the Chesapeake Bay on the north side through Little Creek Inlet. The Navy uses Little Creek, immediately east of Pretty Lake, both for docking ships and conducting training exercises. The U.S. Coast Guard also docks in Little Creek Harbor east of Pretty Lake. Portions of Pretty Lake are navigable by small craft via a primary navigation channel and numerous side channels dredged to individual docks. Multiple private marinas are located just outside of Pretty Lake.

The Need for Action

Portions of the Pretty Lake watershed routinely flood during tidal and storm events, impacting the adjacent neighborhoods and roadways, including Shore Drive, a primary east/west corridor serving the DoD. Shore Drive connects JEB Little Creek with Norfolk, Virginia Beach, and JEB Fort Story, and is the most direct east-west access route for military personnel living in the northern halves of both cities. Frequent recurrent flooding along Shore Drive is well-documented by Norfolk's and Virginia Beach's flood complaint databases (see **Figure 3-20**). According to base personnel, additional flooding occurs on the installation, but is not depicted by city data shown on the map. With the compounding effect of additional sea level rise, flooding along the corridor could worsen significantly in the coming years, as **Figure 3-21** shows.

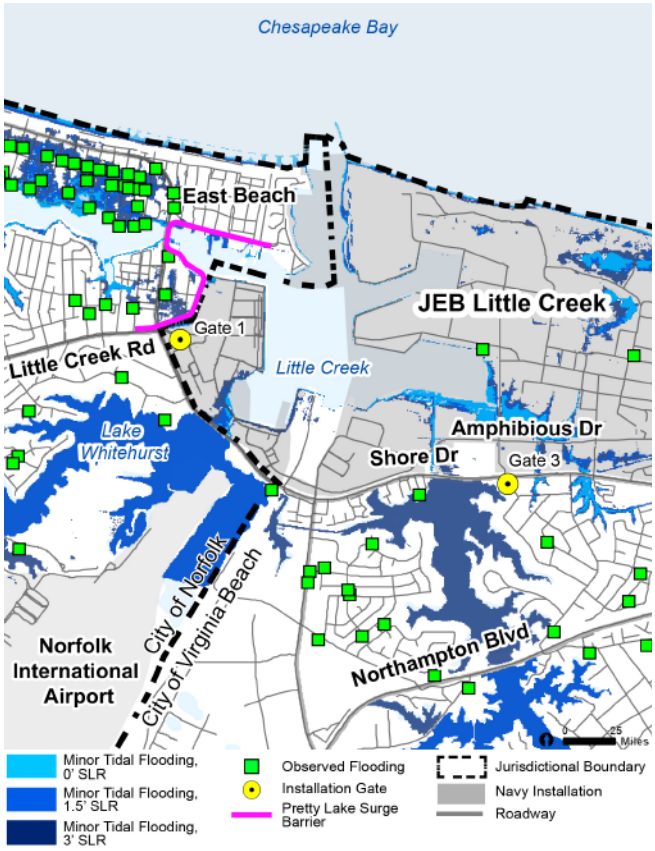


FIGURE 3-20: Action 8: Sea Level Rise Scenarios and Historical Flood Complaints

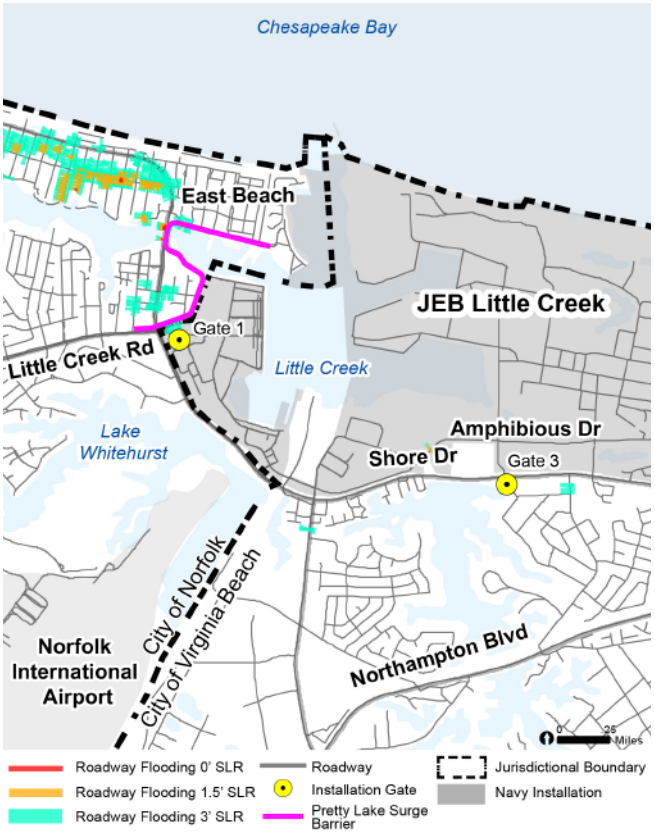


FIGURE 3-21: Action 8: Transportation Infrastructure Vulnerability

Tidal flooding in Pretty Lake from the Chesapeake Bay can also impact nearby neighborhoods, particularly East Beach, and can impede or block access into and out of the area. Access impacts could worsen significantly with additional sea level rise, if they are not addressed, as shown in **Figure 3-22.**

Proposed Action

The 2018 *Final Integrated City of Norfolk USACE CSRM Feasibility Study* proposes implementing a system of measures, including a system of floodwalls and a storm surge barrier, at the mouth of Pretty Lake (adjacent to Little Creek Harbor), to reduce flood risk in the Pretty Lake/Little Creek watershed and protect Shore Drive in this area. The proposed project location is shown on all maps for this Action. As part of the flood risk management strategy, the study also proposes nonstructural measures such as elevating properties, filling basements, and buying out at-risk properties. Additional measures would include living shoreline mitigation and a new oyster reef for Pretty Lake.

According to the study, Shore Drive has an average annual daily traffic volume of 26,000 vehicles. Military personnel commuting to and from work make up a significant percentage of this traffic. This Action would help protect Shore Drive from flooding due to tide and storm surge. The barrier itself would not mitigate flooding in the watershed due to rainfall, though the pumping systems included in the USACE CSRM project conceptual design could assist with

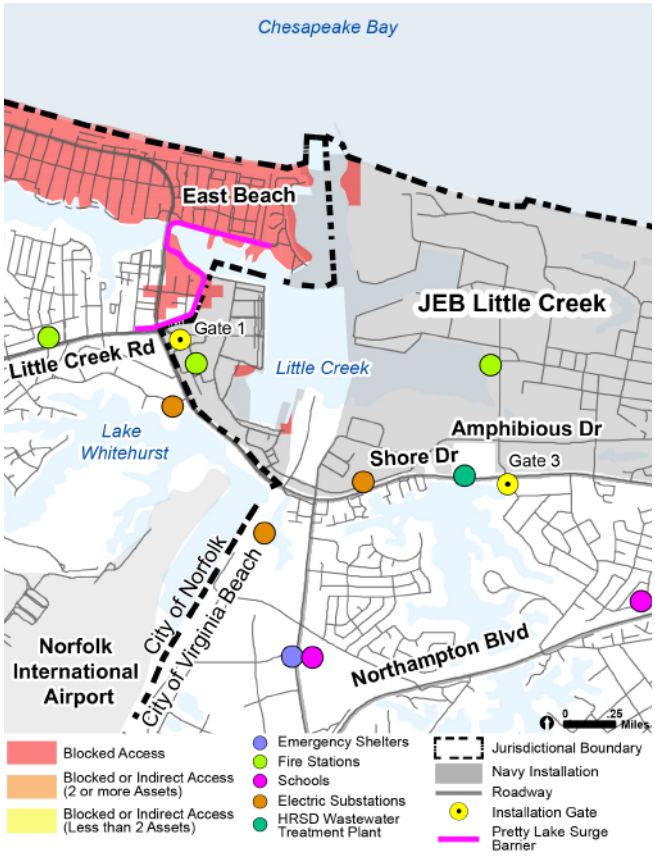


FIGURE 3-22: Action 8: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

precipitation flooding in certain conditions. The project as a whole could be designed in a way that could significantly reduce flood risk to segments of Shore Drive, which would allow personnel to reach the installations more safely and efficiently.

The proposed storm surge barrier would also require segments of floodwall to tie into land on either end of the barrier, as well as a navigable gate at the existing small craft navigation channel under the bridge. Additional engineering design and hydrodynamic, water quality, and sediment transport modeling would also be needed as part of this Action, in addition to environmental impact documentation and permitting coordination. Any impacts to wetlands would require mitigation.

An overland floodwall to prevent storm surge from coming around the surge barrier, south of the Shore Drive bridge, would also be needed. For the USACE CSRM high storm surge design levels, this would likely require street gates that could be closed during flooding events, across either Shore Drive or Little Creek Road, near the intersection.

Potential Operational Impacts to the Navy

Access into and out of Little Creek Harbor is vital to the missions of both the Navy and the U.S. Coast Guard, and both must be able to navigate into and out of the harbor without impediment. Additionally, any significant changes in water level in the harbor could impact the Navy's ability to moor/dock certain ships. The Navy currently has 15 piers and two boat ramps in the Pretty Lake Basin, and is concerned that the proposed storm surge barrier would cause sedimentation/silting, which might interfere with the operation of some of their larger vessels. The Navy has requested that the USACE model potential sediment transport, and provide a detailed plan for regular dredging, if sedimentation remains a concern. The USACE is planning to explore this further, during the PED phase of this project.[1]

The Navy has also expressed concerns about the proposed street gate on Shore Drive, which would be closed during flooding events, therefore blocking access to the western side of the JEB Little Creek installation. This could have a significant impact on mission readiness, as critical personnel still need to access the installation during flood events. The USACE, in response to the Navy's concerns, has pledged to involve the Navy during the PED phase of

1 Per August 22, 2018 letter issued by the USACE to CAPT Richard D. Hayes, II, Commanding Officer, NAVFAC, Mid-Atlantic addressing the Navy's concerns about the Draft Integrated City of Norfolk Coastal Storm Risk Management Feasibility Study/Environmental Impact Statement, Norfolk, Virginia.

the study to ensure that the Navy's operational needs are considered and to ensure that adverse impacts to the Navy's mission are minimized.[2]

Stormwater management of the area impacted by the surge barrier and the way in which floodwaters would be discharged after major storm events is also a Navy concern. The proposed pumping system would require that water contained by the floodwall then be pumped/discharged after the storm event has passed. The USACE has explained that, in order to obtain a National Pollutant Discharge Elimination System (NPDES) Permit, those issues will need to be addressed during the PED phase of the project, prior to constructing the storm surge barrier.[3]

Action Benefits

The design details for this project have not yet been determined. According to the USACE, the project is at 10 percent design level. The benefits described below imply that the preferred design for the project has addressed and resolved the Navy's concerns regarding operational impacts.

- Could be designed to significantly reduce both current and future storm surge flood risk at the intersection of Shore Drive and Little Creek Road, on a strategic corridor between NS Norfolk and JEB Little Creek.
- Could improve access to community facilities that both DoD personnel and civilians rely on, such as fire/emergency stations and elementary schools that also serve as emergency shelters, by reducing the risk of flooding from storm surge to access routes.
- Could reduce current storm surge flood risk to the surrounding community, and protect it from some of the impacts of increased sea level rise.
- Depending on project design and implementation, could provide personnel who live in both Norfolk and Virginia Beach improved access to both JEB Little Creek and JEB Fort Story, as well as other businesses and services located in this area, by reducing storm surge flood risk to Shore Drive,
- If the proposed living shoreline mitigation and new oyster reef are implemented as part of this Action, could potentially benefit the Pretty Lake/ Little Creek ecosystem.

Implementation Steps

1. Coordinate with the Navy and U.S. Coast Guard on PED and all design and implementation phases of this project going forward. This will be critical to prevent and mitigate any potential negative impacts to operations at JEB Little Creek and to secure Navy support for the project.
2. Establish regular coordination meetings with the Navy to provide updates and outcomes on additional modeling and technical analysis requested by the Navy.
3. Follow all USACE-established processes for final plan approval.
4. Norfolk and USACE should work together to identify phasing and jointly pursue funding for project design and implementation. Phasing should consider operational tempo of the Navy and U.S. Coast Guard.
5. Define applicable operating and maintenance parameters as part of any solution.

Other Actions in this area could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest, including:

- Action #2: Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy

2 Ibid
3 Ibid

- Action #3: JEB Little Creek Gate 1 - Amphibious Drive - Shore Drive Flooding Study
- Action #4: East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy

Lead: Norfolk

Partners: USACE, U.S. Navy, U.S. Coast Guard

Funding and Approval Status

The *Final Integrated City of Norfolk USACE CSRM Feasibility Study* has been completed and submitted to Congress, including early stage preliminary design of this action's infrastructure elements. This Action is included as a recommended measure within the overall CSRM plan. PED funding has been allocated in the current fiscal year. However, the presently-allocated PED funds are for a different segment of the overall Norfolk project area.

Cost Range

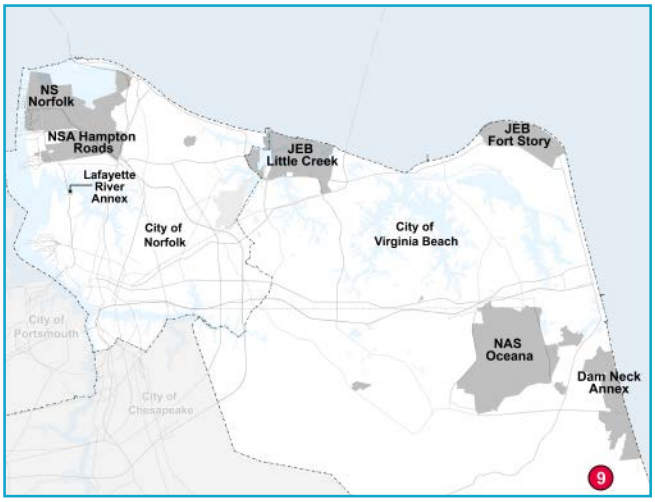
- $$$$$ (> $50M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- NOAA Coastal and Estuarine Land Conservation Program
- NOAA Coastal Resilience Grants
- USACE Section 205: Flood Risk Management Program
- 2018 USACE Supplemental Appropriation
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water State Revolving Fund
- USFWS North America Wetlands Conservation Act 2019-2 U.S. Standard Grants

3.2.9 Nimmo Parkway Extension, Flood Mitigation, and Stormwater Management Improvements, Phases VII-A and VII-B

9



This Action proposes exploring opportunities for additional flood mitigation/protection from the impacts of sea level rise as part of the Virginia Beach Nimmo Parkway Extension CIP project

Action Score: 14

Installation Readiness: **6**

DoD Personnel Readiness: **4**

Co-Benefits: **2**

System Performance and Design: **2**

Nimmo Parkway in Virginia Beach is a critical east-west access route that currently stretches from Princess Anne Road to Albuquerque Drive. The Sandbridge community, located along the Atlantic Ocean in the southeast quadrant of Virginia Beach, just south of Dam Neck Annex, is a low-lying, coastal community vulnerable to flooding from tidal/storm events. There is currently only one public access route in and out of the community, Sandbridge Road, which runs east-west and connects with Princess Anne Road. Virginia Beach has undertaken a CIP project to extend Nimmo Parkway all the way to Sandbridge Road, which is divided into two phases, Phase VII-A and Phase VII-B.

The Need for Action

Recurrent flooding on Sandbridge road due to tidal/storm events can block public access into and out of the community, forcing traffic to be re-routed up Sandpiper Road, through the South Gate of Dam Neck Annex. This requires the Navy and Virginia Beach to both provide additional security personnel to help manage and direct traffic along the detour route. This can impact mission readiness.

Current flooding and access issues will only continue to worsen as sea levels rise. As **Figure 3-23** shows, much of the area will be regularly inundated by flooding under a 3.0-foot sea level rise scenario. Additionally, as **Figure 3-24** shows, a significant portion of the Sandbridge community will have limited or no access to critical community facilities under a

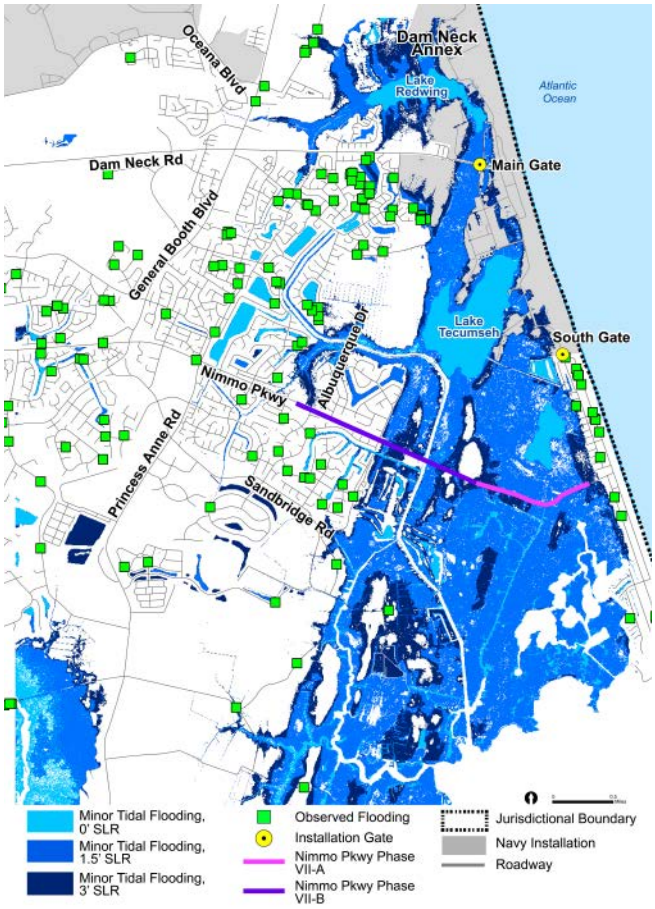


FIGURE 3-23: Action 9: Sea Level Rise Scenarios and Historical Flood Complaints

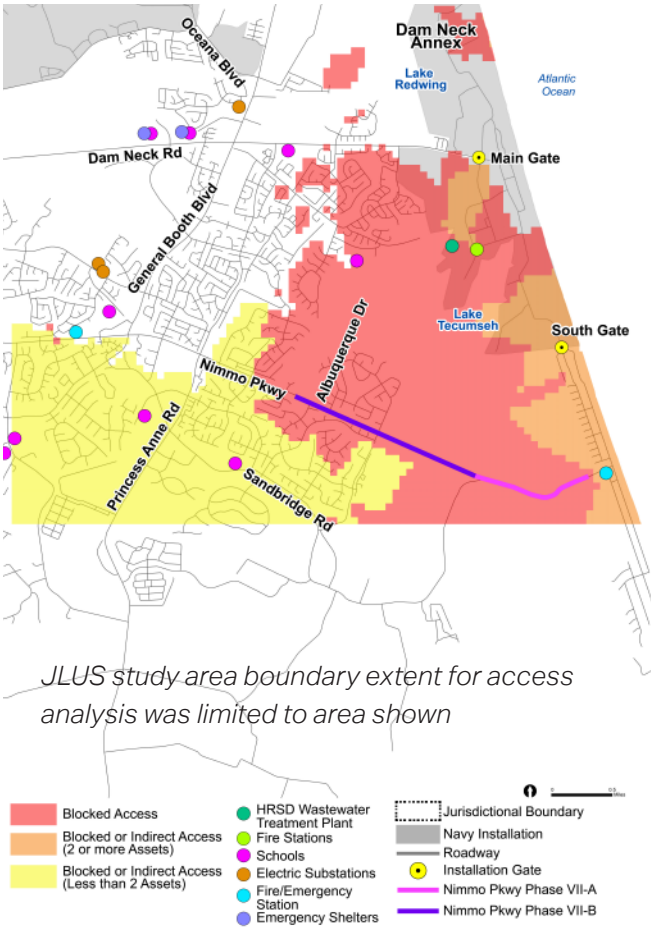


FIGURE 3-24: Action 9: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

3.0-foot SLR scenario, including a fire station and elementary schools that also serve as emergency shelters.

Proposed Action

Virginia Beach's Nimmo Parkway Phase VII-A (Project Reference #2.078.000) will construct a two-lane roadway with on-road bike lanes, a 10-foot shared use path on the south side of the roadway, a new storm system, and new water lines. The project will also raise the roadway elevation to be passable during the 100-year flood, and takes into account the possibility of up to 3.0 additional feet of sea level rise.

The Phase VII-A project extends from Sandpiper Road to Atwoodtown Road, and will eventually connect with the roadway segment being constructed as part of Phase VII-B, which begins at Albuquerque Drive. This phase of the CIP project is already underway. According to Virginia Beach's CIP project database, environmental permits have been received, and 90 percent design plans are currently being developed. Coordination with private utilities is also ongoing.

Nimmo Parkway Phase VII-B (Project Reference #2.110.000) will construct a two-lane roadway with on-road bike lanes and a 10-foot shared use path on

the south side of the roadway. The Phase VII-B project extends from Albuquerque Drive to the western terminus of the Nimmo Parkway Phase VII-A project. Construction of Phase VII-B will complete the Nimmo Parkway corridor and provide direct access to Sandbridge and adjacent communities. This connection will alleviate the need for traffic to be routed through Dam Neck Annex. An Environmental Agency scoping meeting for this phase of the project was held in April 2019, and Virginia Beach is currently in the process of preparing the required National Environmental Policy Act (NEPA) environmental documentation and coordinating with state/federal agencies as necessary.

While the current CIP project as it stands provides many benefits, there are potential opportunities to provide additional flood risk mitigation to the surrounding community as the corridor projects are advanced. Nimmo Parkway crosses wetlands and floodplain areas that are currently a pathway for flooding from Back Bay into areas north of the roadway. Thus, the parkway, when fully constructed, may present opportunities for adding features to mitigate potential flood risk. The area adjacent to Nimmo Parkway has also been highlighted by Virginia Beach's Comprehensive Sea Level Rise and Recurrent Flooding Planning Study as a "Focus Area for Adaptation" to sea level rise. With this Action, there are also potential opportunities to involve additional interested stakeholders (like the Navy), to lend support for enhanced design features that ensure the long-term viability/reliability of this route.

Action Benefits

- Will provide much more reliable access to and from the Sandbridge area during minor tidal flooding events, even with 3.0 feet of sea level rise. This will benefit Dam Neck Annex by providing a more reliable egress from the base, and will also reduce the need to route traffic through the base during a flood event.
- Could lead to additional features being included in the completion of Nimmo Parkway that could significantly reduce current and future flood risk along a corridor that serves Dam Neck Annex and could also potentially be used by DoD personnel accessing Naval Auxiliary Landing Field Fentress in Chesapeake.
- Could improve access to community facilities that DoD personnel rely upon, including elementary schools that also serve as emergency shelters.
- With the addition of a shared-use path, creates potential recreational and health benefits for the surrounding community and DoD.

Implementation Steps

1. Complete construction of Phase VII-A.
2. Use the ongoing engineering design process of Phase VII-B to evaluate ways to use the Nimmo Parkway corridor to mitigate flooding in areas north of the corridor. This is consistent with recommendations from Virginia Beach's *Comprehensive Sea Level Rise and Recurrent Flooding Planning Study.*
3. Pursue funding for incorporation of any such flooding mitigation features into the construction of Phase VII-B.
4. Define applicable operating and maintenance parameters as part of any solution.

Lead: Virginia Beach

Partners: N/A

Funding and Approval Status

- Funding has been allocated for Nimmo Parkway Extension, Phase CIP project.

- However, no funding has been allocated for study of additional strategies arising out of the City's *Comprehensive Sea Level Rise and Recurrent Flooding Planning Study*.

Cost Range

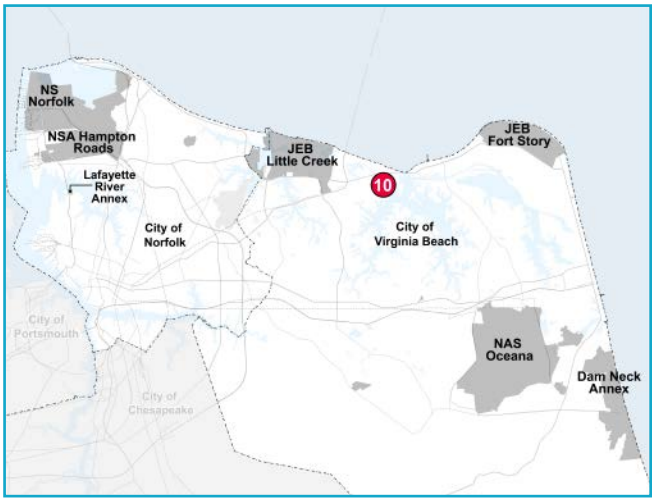
- $$$$$ (> $50M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- Virginia's Transportation Funding (VDOT, DRPT)
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)

3.2.10 Pleasure House Point Flood Mitigation Strategy

10



This Action recommends a flood mitigation strategy in the Pleasure House Point area of Virginia Beach to mitigate flood risk to the portion of Shore Drive immediately west of the Lesner Bridge.

Action Score: 14

Installation Readiness: **6**

DoD Personnel Readiness: **4**

Co-Benefits: **2**

System Performance and Design: **2**

Flooding due to tidal/rain events along Shore Drive can impede or even block access between the JEB Little Creek and JEB Fort Story. Because Shore Drive is a major, heavily traveled east-west corridor, flooding on the roadway also impacts access to community assets and emergency services for both DoD personnel and civilians. Pleasure House Point is located on the western side of the Lynnhaven River Inlet in Virginia Beach, south of Shore Drive. Shore Drive crosses the inlet at the Lesner Bridge, and is the main east/west access route for the northern half of Virginia Beach. It is also the primary access route between the JEB Little Creek and JEB Fort Story installations.

The Need for Action

As shown in **Figure 3-25**, historical flood complaint data from Virginia Beach documents multiple complaints about recurrent flooding along the portion of Shore Drive west of the Lesner Bridge. With 3 additional feet of sea level rise, as shown in **Figure 3-26,** several neighborhoods in this area would experience blocked access to community assets, and would be unable to access any assets east of the bridge.

According to the transportation infrastructure vulnerability analysis (see **Figure 3-27**), as sea levels continue to rise, this segment of Shore Drive immediately west of the Lesner Bridge could also begin to experience more routine flooding during tidal/rain events. This segment of Shore Drive drains through a system of pipes that outfall into Pleasure

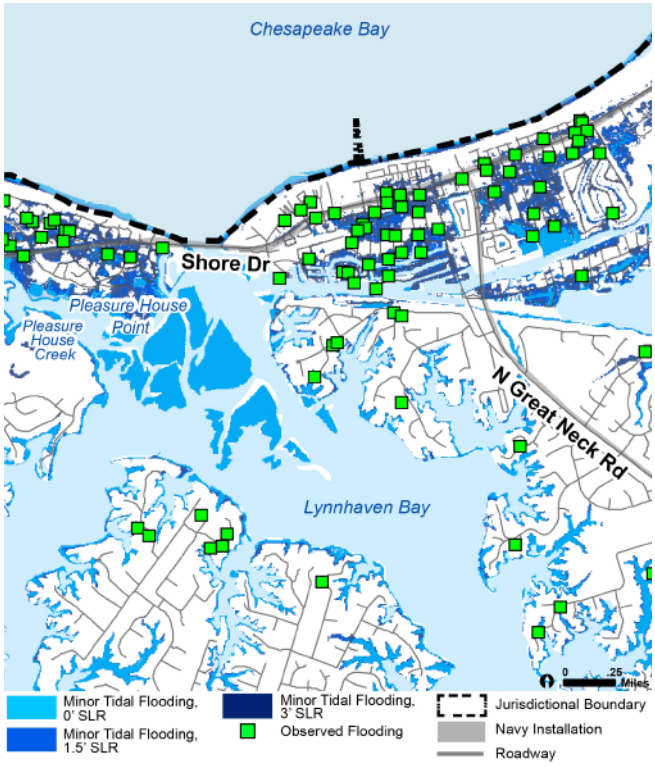


FIGURE 3-25: Action 10: Sea Level Rise Scenarios and Historical Flood Complaints

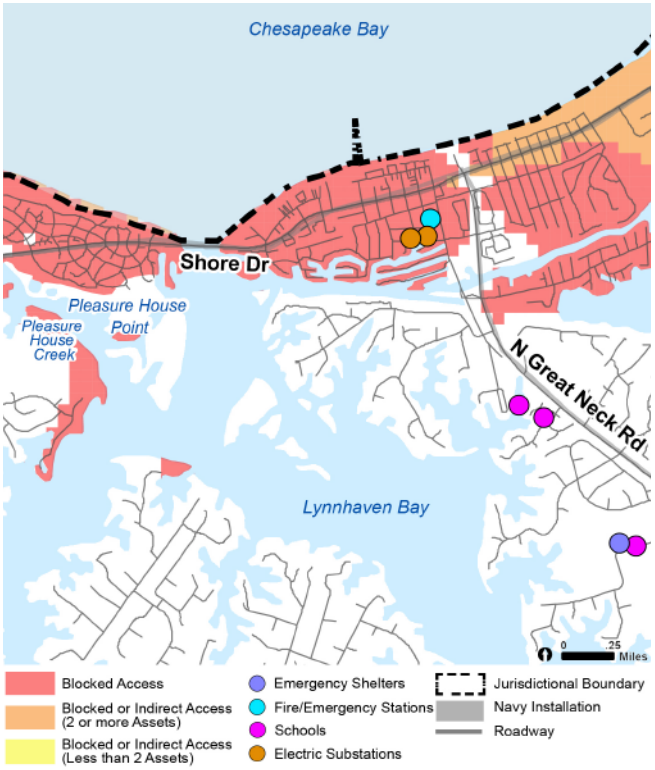


FIGURE 3-26: Action 10: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

House Creek and Crab Creek, both of which are tidal waters connected to the Chesapeake Bay through Lynnhaven Inlet. At current sea level, high tides can inhibit stormwater drainage and contribute to precipitation flooding. As sea levels rise, minor tidal flooding events could directly cause flooding on Shore Drive in this area.

Proposed Action

A flood mitigation strategy centered around the Pleasure House Point area could help reduce both current and future flood risk to the section of Shore Drive immediately west of the Lesner Bridge. As part of this strategy, options to install backflow preventers, such as tide gates or Checkmate®-type valves (or similar), on all of the stormwater outfalls that drain Shore Drive and the neighborhoods to the south should be explored. Installing tide gates in this area would also help to preserve and protect existing wetlands vegetation and habitat. Enhancing the existing raised ridge of land within the Pleasure House Point natural area should also be considered as a component of the overall strategy, as a nature-based feature to prevent tidal flooding from coming over land from the south to inundate Shore Drive.

Implementing a larger, controllable tide gate at or near the Shore Drive crossing over Pleasure House Creek between First Court Road and Marlin Bay Drive could also help reduce flood risk to this section of the corridor. As part of the proposed Action strategy, H&H studies, along with wetland delineation and environmental impact documentation, should be strongly considered.

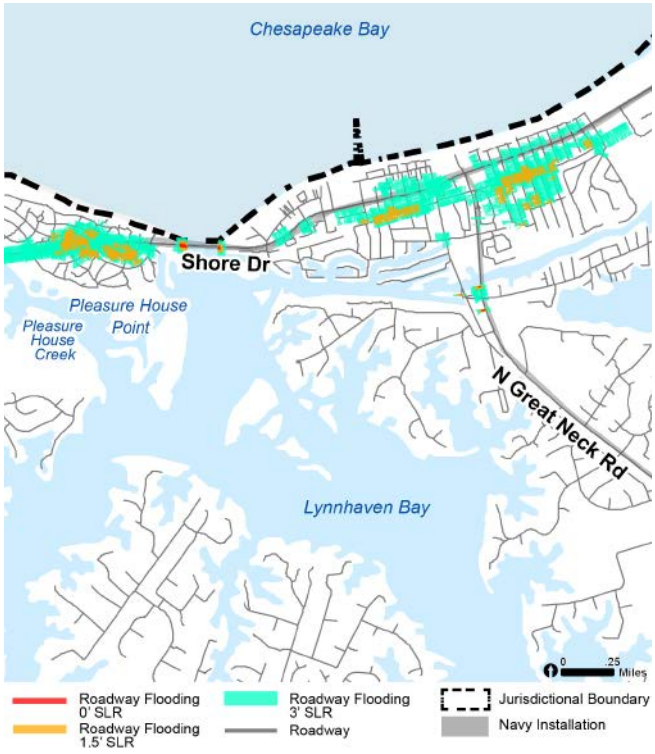


FIGURE 3-27: Action 10: Transportation Infrastructure Vulnerability

Implementing this type of strategy could address the current issue of recurrent nuisance flooding on Shore Drive west of the Lesner Bridge, and prepare for expected levels of sea level rise, to improve access for military personnel between JEB Little Creek and JEB Fort Story. The action and implementation steps recommended for this specific portion of Shore Drive would also fit as a component of the larger-scale action to develop a comprehensive strategy for Shore Drive, from JEB Little Creek to JEB Fort Story (Action #2).

Action Benefits

- Could lead to a flood mitigation strategy that would significantly reduce both current and future flood risk along a portion of Shore Drive, a strategic corridor connecting the JEB Little Creek and JEB Fort Story.
- Could lead to a flood mitigation strategy that would improve access via Shore Drive and adjacent local roads to community facilities that both DoD personnel and civilians rely on, including fire/emergency stations and elementary schools that also serve as emergency shelters.
- Enhancements to existing natural areas could provide opportunities for community recreation–for example, a trail along the proposed berm.
- Considers future conditions, including additional sea level rise.

Implementation Steps

Recommended implementation steps include:

1. Utilize Virginia Beach's *Stormwater Master Plan Update* models, and all other existing studies, drainage basin models, and other planning and/or design work done for this area as a baseline for studying:
    a. Options to install backflow preventers on all of the stormwater outfalls that drain Shore Drive and the neighborhoods to the south
    b. Enhancing the existing natural ridge of land within the Pleasure House Point natural area to mitigate tidal flooding
    c. Implementing a larger, controllable tide gate at or near the Shore Drive crossing over Pleasure House Creek
2. Pursue funding that will allow for additional options for flood mitigation in this area to be explored/studied further.
3. Undertake any H&H studies, wetlands delineation, and environmental studies deemed necessary as part of this action.
4. Determine preferred suite of projects appropriate to address flooding in this location.

5. Identify phasing and pursue funding for project implementation.
6. Define applicable operating and maintenance parameters as part of any solution.

Other Actions in this area could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest. Nearby related actions include:

- Action #2: Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy

Lead: Virginia Beach

Partners: N/A

Funding and Approval Status

Although studies/models exist for this area, no official study or planning work has been initiated for this specific action. No funding is in place for this specific action.

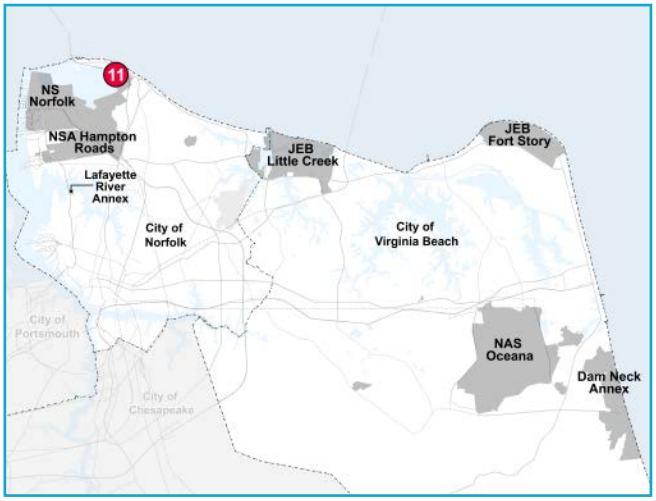
Cost Range

- $$$$ ($10M – $25M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- NOAA Coastal and Estuarine Land Conservation Program
- NOAA Coastal Resilience Grant
- USACE Section 103: Hurricane and Storm Beach Erosion
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- FHWA Recreational Trails Program
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water State Revolving Fund
- USFWS North America Wetlands Conservation Act 2019-2 U.S. Standard Grants

3.2.11 Willoughby Spit Flood Mitigation Strategy 11



This Action proposes to use the USACE CSRM feasibility study as a springboard to further evaluate using dunes, earthen berms, floodwalls, and stormwater management improvements along Willoughby Spit to keep storm surge and waves from inundating Ocean View Avenue and impacting the surrounding community.

Action Score: 14

Installation Readiness: **6**

DoD Personnel Readiness: **4**

Co-Benefits: **2**

System Performance and Design: **2**

The Willoughby Spit shoreline in Norfolk is subject to regular tidal flooding and storm surge from the Chesapeake Bay and the Willoughby Bay. Tidal flooding and storm surge also impacts the main local transportation route along Willoughby Spit, Ocean View Avenue. Ocean View Avenue is a primary corridor serving the DoD that connects the northwestern section of Norfolk with Shore Drive, a primary east-west access route serving JEB Little Creek and JEB Fort Story.

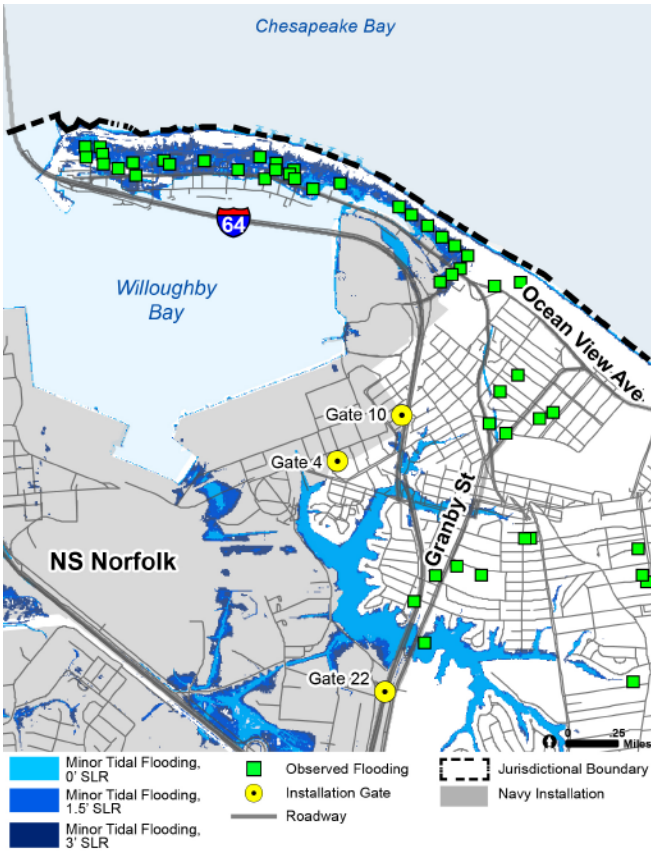


FIGURE 3-28: Action 11: Sea Level Rise Scenarios and Historical Flood Complaints

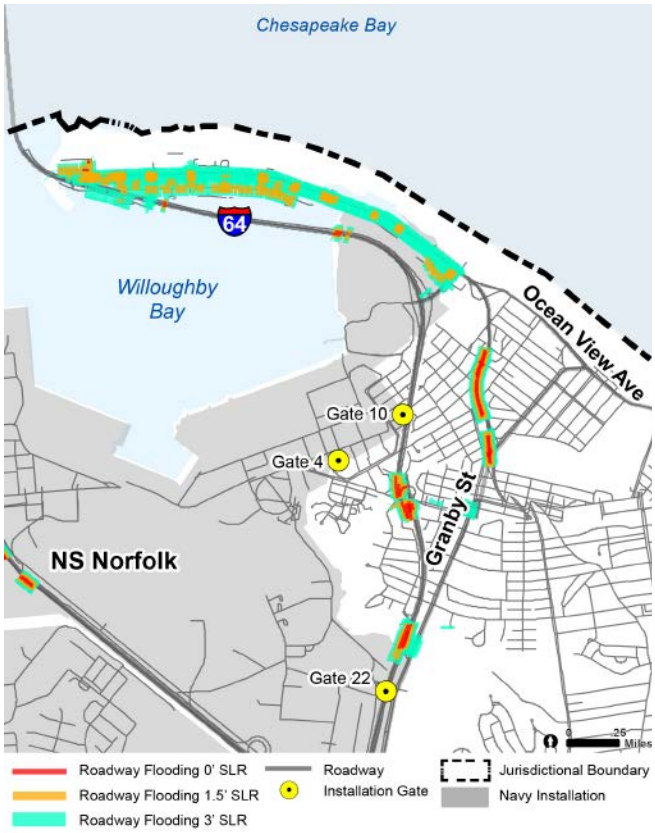


FIGURE 3-29: Action 11: Transportation Infrastructure Vulnerability

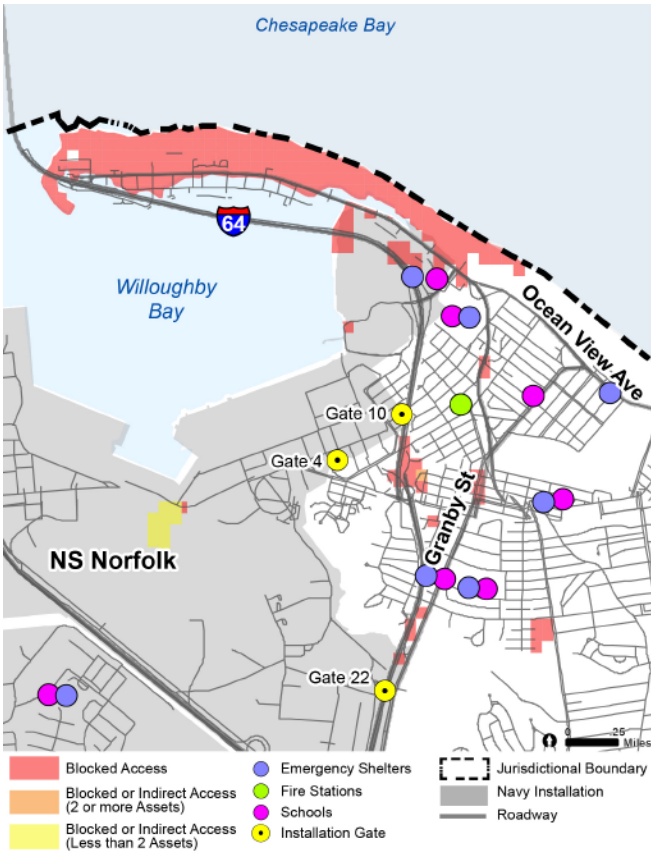


FIGURE 3-30: Action 11: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

The Need for Action

In addition to the direct impacts to the Willoughby Bay shoreline, minor to moderate tidal flooding events cause the storm drainage system serving Ocean View Avenue to back up, increasing the depth and duration of rainfall-related flooding on Ocean View Avenue and connected side streets. This can cause major traffic congestion, or even block the roadway, depending on the depth of the flooding.

Historical flooding observations in Norfolk confirm that Ocean View Avenue floods in relatively infrequent hurricanes (such Hurricane Irene and Hurricane Sandy), and also during heavy rainfalls and thunderstorms (see **Figure 3-28**). Street flooding in Willoughby Spit currently impacts the ability of residents to access community facilities such as schools, shelters and emergency services, as shown in **Figure 3-29** and **Figure 3-30**. Because Ocean View Avenue connects to arterial roads that lead to NS Norfolk and JEB Little Creek, flooding that affects transportation along this route can impact the ability of residents employed by the military to get to work.

A number of community assets (such as schools, shelters, and emergency response stations) are located along Ocean View Avenue, which is a critical evacuation route connecting the community to I-64. Additional sea level rise could exacerbate roadway flooding along Ocean View Avenue, further impeding or even blocking access to critical community assets.

Figure 3-30 shows potential access issues under a scenario of 3.0 feet of sea level rise with minor tidal flooding.

Proposed Action

This action recommends studying the feasibility of raising the dunes along Willoughby Spit in Norfolk, in conjunction with floodwalls/earthen berms and stormwater outfall improvements along the southern shoreline of Willoughby Spit to significantly reduce the impact of storm surge and waves on Ocean View Avenue and the surrounding community.

In addition to raising the dunes, floodwalls, earthen berms, and stormwater outfall improvements, along the Willoughby Bay shoreline could mitigate flooding south of Ocean View Avenue that could not be addressed by the existing beach and dune system.

This action could complement the currently authorized federal beach expansion along the 7 miles of Willoughby Spit and Ocean View shoreline that was initially constructed in May 2017 with a federal commitment over multiple decades to maintain the beach through periodic nourishment. The federally authorized and constructed expanded beach berm could help keep wave action from the toe of new dunes constructed as a result of this action, and the dry sandy beach could continually supply the vegetated dunes with more sand. In turn, the dunes could provide higher levels of storm protection than the current beach can provide by itself.

Action Benefits

- Could reduce current and future flood risk for military personnel along Ocean View Avenue, a primary DoD strategic corridor.
- Could improve access to community assets that serve both DoD personnel and civilians, including elementary schools that also serve as emergency shelters.
- Could reduce current flood risk for the surrounding community and help mitigate against some impacts associated with future sea level rise.

Implementation Steps

1. Use the *Final Integrated City of Norfolk USACE CSRM Feasibility Study* as a foundation for further study and evaluation of:
    a. Constructing larger dunes along the Chesapeake Bay shoreline of Willoughby Spit with consistent dune crest elevations and dune volumes to associate with a certain storm level of protection
    b. Constructing a system of floodwalls and berms along the southern Willoughby Bay shoreline of Willoughby Spit. The pieces of this system could have varied types and shapes to fit within the existing nature of the shoreline segments
    c. Installing backflow preventers on the stormwater outfalls that drain this area
    d. Constructing and operating pumping stations to manage interior drainage from the protected area
2. Pursue funding for further study.
3. Engage in a planning and engineering concept study to determine most appropriate elevations.
4. Determine preferred design solutions to meet project goals.
5. Identify phasing and pursue funding for project implementation.
6. Define applicable operating and maintenance parameters as part of any solution.

Lead: Norfolk

Partners: N/A

Funding and Approval Status

This project was evaluated in the draft USACE Norfolk CSRM study, but was not included in the final study. The *Final Integrated City of Norfolk USACE CSRM Feasibility Study* can be used as a foundation for this action, but it is recommended that this Action be treated as a new and separate action from the Draft Study. This would allow Norfolk to apply its own cost/benefit analysis methodology, and undertake a more detailed and specific feasibility study for the proposed Actions.

Cost Range

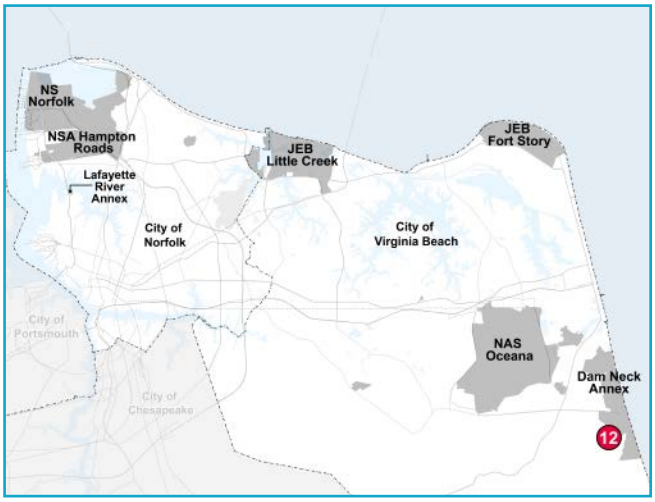
- $$$$ ($10M – $25M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- VA DCR Dam Safety and Floodplain Management Grants
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- NOAA Coastal and Estuarine Land Conservation Program
- NOAA Coastal Resilience Grants
- USACE Section 205: Flood Risk Management Program
- USACE Section 103: Hurricane and Storm Beach Erosion
- 2018 USACE Supplemental Appropriation
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water State Revolving Fund
- USFWS North America Wetlands Conservation Act 2019-2 U.S. Standard Grants
- U.S. HUD CDBG Entitlement Program

3.2.12 Lake Tecumseh and Lake Redwing Management Strategy

12



This Action recommends development of a lake-level management strategy for Lake Tecumseh and Lake Redwing.

Action Score: 11

Installation Readiness: **3**

DoD Personnel Readiness: **4**

Co-Benefits: **2**

System Performance and Design: **2**

Lake Redwing is located adjacent to the northern border of Dam Neck Annex and Lake Tecumseh is located on the southern end of the installation. Both lakes are influenced by water levels in Ashville Bridge Creek, which connects with Back Bay and Currituck Sound. While not regularly tidal, wind tides affecting Back Bay raise water levels in Ashville Bridge Creek, which can affect water levels in both Lake Tecumseh and Lake Redwing.

The Need for Action

Dam Neck Annex currently experiences recurrent on-base flooding from the two lakes. This can impact structures on the installation, particularly on the northern end.

Currently, there is a weir in place that controls the water level between the Ashville Bridge Creek canal and Lake Tecumseh. The weir belongs to the USACE, but it is not sufficient to prevent the lake from flooding portions of the installation during wind tide and precipitation events. Flooding impacts to critical facilities on base is a direct impediment to mission readiness. This is an ongoing issue, and could therefore worsen due to the impacts of future sea level rise on water levels in Back Bay and thus in Ashville Bridge Creek downstream of Lake Tecumseh, as **Figure 3-31** shows.

Proposed Action

This Action recommends the development of a lake-level management strategy that would include an evaluation of the functionality of the existing weir

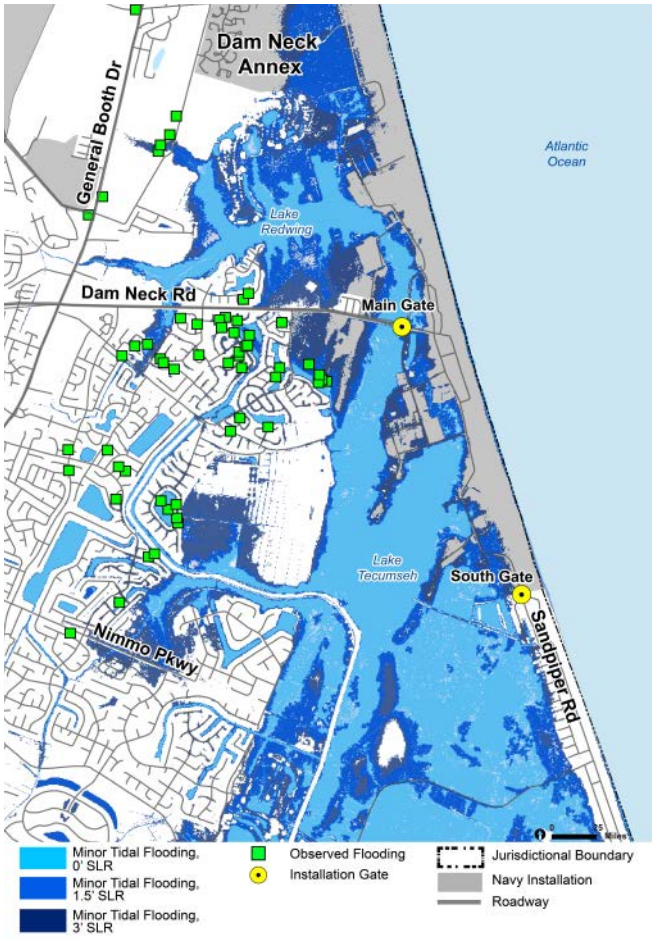


FIGURE 3-31: Action 12: Sea Level Rise Scenarios and Historical Flood Complaints

and improvements to the drainage connection between the two lakes. The study should also evaluate options for controlling lake levels with a pump or similar mechanism. **Figure 3-32** provides a closer view of the study area.

The compounding effects of future sea level rise would need to be taken into consideration in the planning and design phases, to ensure that the proposed strategy would be effective at controlling lake levels and preventing flooding on the installation well into the future.

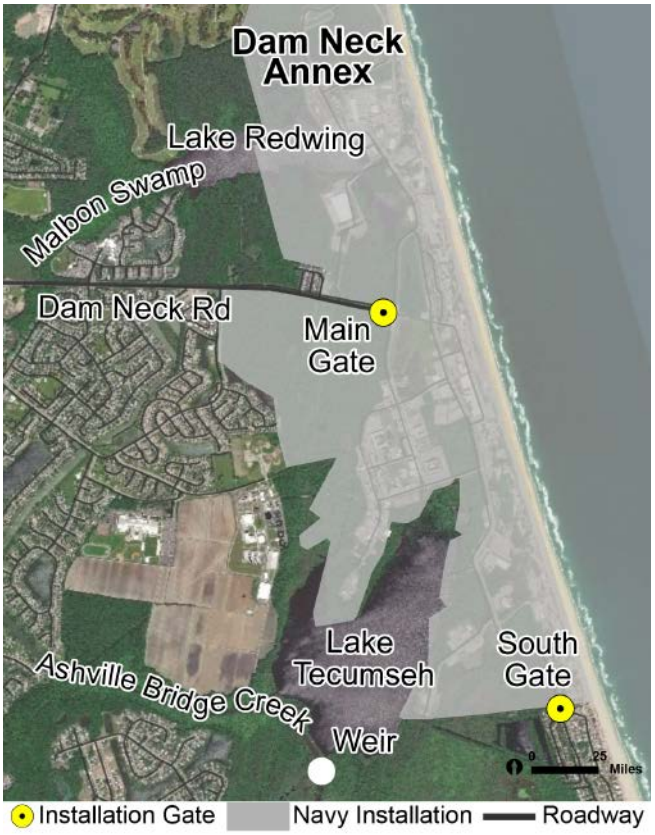


FIGURE 3-32: Action 12: Approximate Action Location

An H&H study may need to be undertaken as part of this Action, to evaluate the existing drainage conditions, if Virginia Beach's *Master Drainage Plan* and/or any other studies or models done in the area provide insufficient information to inform the lake level management strategy.

This Action recommends that a field survey be undertaken to record information on the lakes (including hydrographic survey of lake bed elevations), the connecting ditch, and the weir structure. Areas that historically flood around the lakes, the connecting ditch between them, and the weir structure should also be recorded as part of this study.

The study would require significant coordination between technical staff from Virginia Beach and the Navy to ensure that the solutions do not generate adverse impacts to the installation.

Additionally, wetlands delineation and other environmental impact documentation would most likely be required in the event that the agreed-upon strategy recommends significant changes to how the lakes are managed.

Action Benefits

- Identifies opportunities to significantly reduce current and future flood risk to facilities and roadways on the Dam Neck Annex.
- Could identify opportunities to improve internal base access.
- Could identify opportunities to reduce flood risk to Dam Neck Road and benefit both civilians and DoD personnel who regularly use the roadway to access homes, jobs, and community facilities.
- Creates opportunities to reduce invasive species in the canal connecting the two lakes, thereby providing ecosystem benefits as part of the overall strategy.
- Addresses future conditions, including additional sea level rise.

Implementation Steps

1. Form a working partnership between Virginia Beach and the Navy to coordinate and oversee the study.
2. Jointly define the parameters for the study.
3. Pursue funding for study.
4. Utilize all existing studies, drainage basin models, and other planning and/or design work done for this area as a baseline for this study, including the Virginia Beach *Stormwater Master Plan Update*.
5. Once causes of flooding are determined, jointly determine preferred design solutions to address flooding.
6. Identify phasing and jointly pursue funding for project implementation.
7. Define applicable operating and maintenance parameters as part of any solution.

Other actions in this area could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest. Nearby related actions include:

- Action #6: Dam Neck Gate Flood Impact Study

Lead: Virginia Beach

Partners: U.S. Navy

Funding and Approval Status

No official planning work has been initiated for this Action, and there is no funding currently allocated for the proposed study.

Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

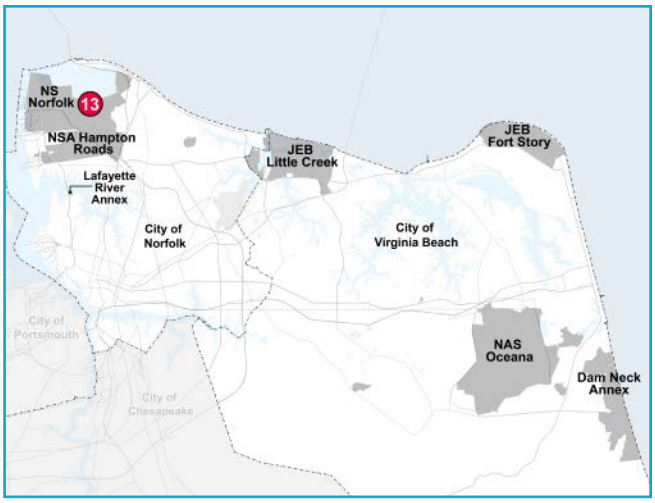
Potential Funding Sources

- Virginia Beach CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- NOAA Coastal and Estuarine Land Conservation Program

- NOAA Coastal Resilience Grant
- USACE Section 205: Flood Risk Management Program
- USACE Section 103: Hurricane and Storm Beach Erosion
- 2018 USACE Supplemental Appropriation
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water State Revolving Fund
- USFWS North America Wetlands Conservation Act 2019-2 U.S. Standard Grants

3.2.13 Willoughby Bay Shoreline Floodwall Options

13



This Action proposes investigating options for constructing a floodwall along the Bellinger Boulevard corridor bulkhead edge located on NS Norfolk.

Action Score: 11

Installation Readiness: **6**

DoD Personnel Readiness: **2**

Co-Benefits: **1**

System Performance and Design: **2**

NS Norfolk's northern border runs along the Willoughby Bay shoreline. Willoughby Bay is open to the Elizabeth River on the west, which is directly connected to the Chesapeake Bay to the north.

The Need for Action

A segment of Bellinger Boulevard on NS Norfolk, a critical route within the installation that provides the only direct east-west access route north of the runway, is currently subject to over-topping by tidal flooding and storm surge. It is also the only direct connection between Gates 4, 10, and 22, and the central and western parts of the installation. Discussions with the Navy confirmed that this is an ongoing issue of concern. Over-topping of the bulkhead floods Bellinger Boulevard and inundates low-lying areas along the NS Norfolk Chambers Field runway and taxiways, impacting on-base traffic flow and compromising installation readiness.

Future additional sea level rise would increase the frequency of flooding over the bulkhead. The taxiways north of the runway are currently at elevations that would be inundated by moderate tidal flooding in the 3.0 feet of SLR scenario, as shown in **Figure 3-33**.

Flooding from Willoughby Bay also has the potential to contribute to flooding in the Mason Creek neighborhood to the southeast, an area already subject to frequent nuisance flooding from high-volume rainfall events occurring when the tide gate is closed (at very high tides or during storm surges).

With 3 additional feet of sea level rise, storm surges over-topping the bulkhead would be able to bypass into Mason Creek and adjacent low areas, defeating the existing benefits provided by the Mason Creek

FIGURE 3-33: Action 13: Sea Level Rise Scenarios and Historical Flood Complaints

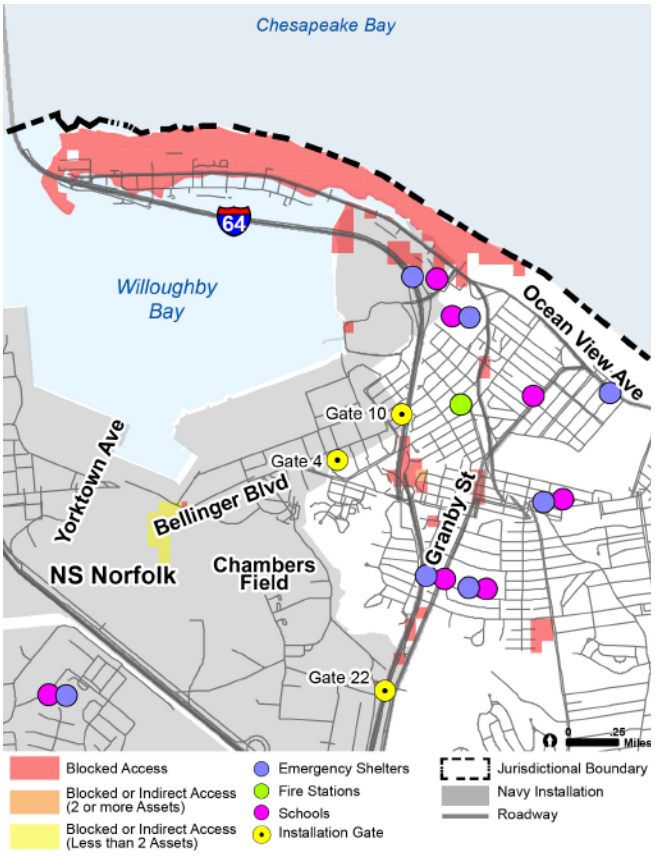


FIGURE 3-34: Action 13: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

culvert tide gate. Storm surges bypassing the tide gate in this way would have the potential to cause flooding in the neighborhood adjacent to Mason Creek, impacting roadways and properties, and potentially impacting access to base and community assets, as **Figure 3-34** shows.

Proposed Action

This Action proposes investigating options for constructing a floodwall along the Bellinger Boulevard corridor bulkhead edge located on NS Norfolk, to mitigate storm surge flooding over a low section of bulkhead. This action is intended to address the current flooding issues along Bellinger Boulevard, and prevent the compounding impacts that would occur with an additional 1.5 to 3.0 feet of sea level rise.

The project could be accomplished by constructing a new, relatively low-height floodwall behind the existing bulkhead. Design alternatives may include raising segments of the existing bulkhead elevation by 2 to 3 feet. Raising the edge of NS Norfolk locally along this stretch of Bellinger Boulevard could keep tidal flooding off of Bellinger Boulevard, and the taxiways, and could prevent additional impacts from rising sea levels, depending on the floodwall design.

Raising the installation edge along Bellinger Boulevard could also mitigate flood risk to Mason Creek. It may also allow Norfolk to obtain a map revision to mitigate the Flood Insurance Rate Maps (FIRM) zones and flood insurance requirements for Mason Creek residents, provided that the project is

designed to FEMA requirements for flood protection structures, and if both the floodwall and the tide gate are certified and accredited by FEMA.

As part of an effective floodwall project design, backflow preventers would be required on several existing stormwater outfalls through the existing bulkhead or rip rap. Some localized grading behind a new floodwall may be necessary for managing stormwater drainage.

This Action's benefit to the adjacent Mason Creek community could be enhanced by improvements to the existing NS Norfolk Mason Creek tide gate (Action #2, Mason Creek Flood Mitigation Strategy) and/or the installation of a pumping station to work in conjunction with the Mason Creek tide gate (as previously evaluated by Norfolk).

Action Benefits

- Could identify opportunities to greatly reduce current flood risk to Bellinger Boulevard, a strategic on-base access route.
- Could identify opportunities to reduce flood risk to Chambers Field runways and taxiways, which are critical to the installation's mission.
- Could provide opportunities to reduce current flood risk to the Mason Creek community and the community facilities that serve area residents.
- Could provide protection from future flooding due to sea level rise.

Implementation Steps

1. Use preliminary project planning work from draft USACE Norfolk CSRM study as a basis for establishing a course of action for further project study, planning, and design.
2. Pursue funding for the preliminary engineering and design study.
3. Jointly determine preferred design solutions to meet project goals.
4. Apply for and obtain all necessary local, state, and federal permits.
5. Identify phasing and jointly pursue funding for project implementation.

Lead: U.S. Navy

Partner: Norfolk

Funding and Approval Status

- No further design or planning work has been done.
- This project was identified in the first iteration of the draft USACE Norfolk CSRM study, but was not included in the final draft due to the results of USACE's economic feasibility analysis.

Cost Range

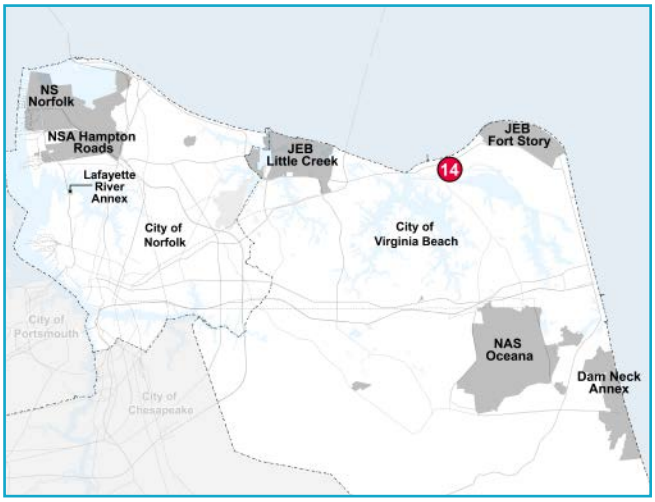
- $$$ ($1M – $10M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- VA DCR Dam Safety and Floodplain Management Grants
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- USACE Section 205: Flood Risk Management Program
- USACE Section 14: Emergency Stream bank and Shoreline Protection
- 2018 USACE Supplemental Appropriation

3.2.14 Fire Station 1/EMS 22 First Landing Vulnerability Assessment

14



This Action recommends a site-level vulnerability assessment of the First Station 1/ EMS 22 First Landing facility.

Action Score: 9

Installation Readiness: **0**

DoD Personnel Readiness: **6**

Co-Benefits: **2**

System Performance and Design: **1**

Fire Station 1/EMS 22 First Landing, located at the intersection of Shore Drive and Great Neck Road, provides emergency services to the area east of the Lesner Bridge, on the north and east side of Virginia Beach. This station does not directly support JEB Fort Story, but would provide emergency backup support to Fort Story's on-base fire station if needed. The location of the station is along a primary strategic corridor serving the military and the primary access route to JEB Fort Story.

The Need for Action

Recurring minor tidal flooding already occurs in some of the lower-lying areas surrounding Fire Station 1/ EMS 22 First Landing, and will continue to worsen as sea levels rise, as **Figure 3-35** shows. The community asset exposure analysis indicates that the station itself will potentially be regularly exposed to recurring minor tidal flooding at 3 feet of sea level rise. Both the access analysis (see **Figure 3-36**) and the transportation vulnerability analysis (see **Figure 3-37**) indicate that access to and from the facility could be impeded sooner at 1.5 feet of sea level rise, depending on tidal conditions. This could have a serious impact on the safety and welfare of the surrounding community served by the station.

Proposed Action

Additional study is needed to better analyze and determine the potential impacts of additional sea level rise on Fire Station 1/EMS 22 First Landing. This Action proposes conducting a comprehensive

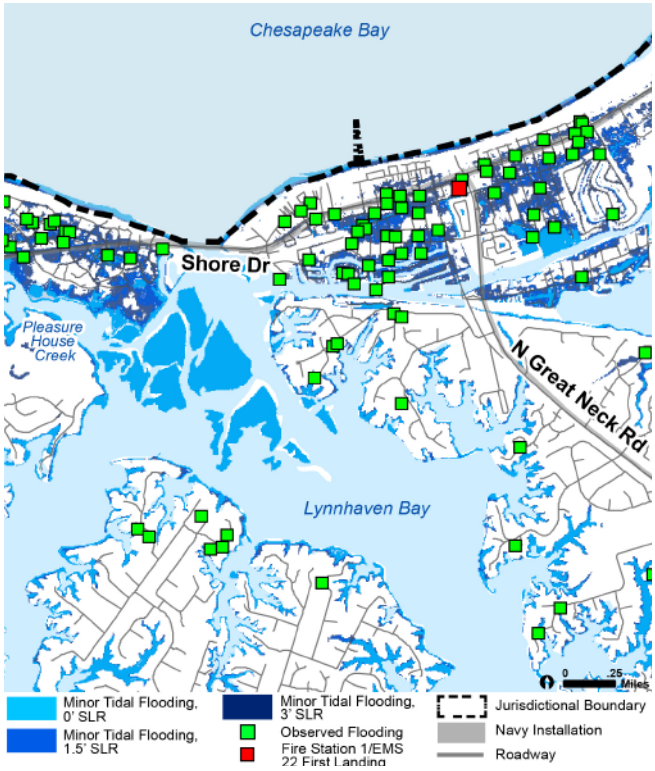


FIGURE 3-35: Action 14: Sea Level Rise Scenarios and Historical Flood Complaints

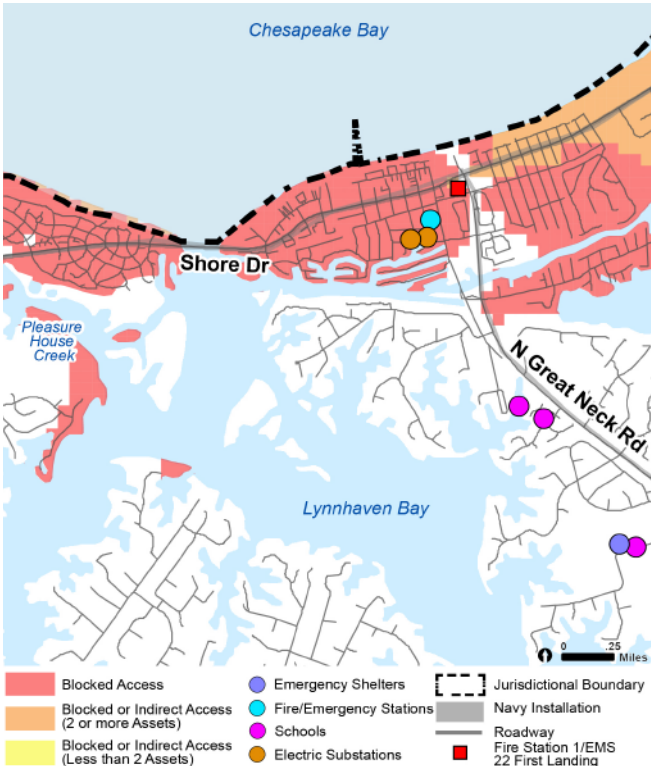


FIGURE 3-36: Action 14: Transportation Infrastructure Vulnerability under Minor Tidal Flooding with 3.0 feet of SLR

vulnerability assessment to determine future access and flooding impacts so that appropriate courses of action can be determined before flooding becomes problematic. The study should be coordinated with Virginia Beach's emergency management personnel. The city should coordinate with the Navy to understand potential impacts on cooperative services. The study should evaluate a range of engineering options to address the impacts, such as facility floodproofing upgrades or potentially relocating the facility to a less vulnerable location.

Virginia Beach's *Stormwater Master Plan Update* model and the *Comprehensive Sea Level Rise and Recurrent Flooding Plan* should be used as inputs for this site-level analysis.

Action Benefits

- Could identify opportunities to improve access along Shore Drive.
- Could identify opportunities to improve access to and from a critical emergency facility that serves the community and provides backup support to the DoD.
- Could identify opportunities to directly protect a critical community facility from long-term flooding impacts.
- Addresses future conditions, including additional sea level rise.

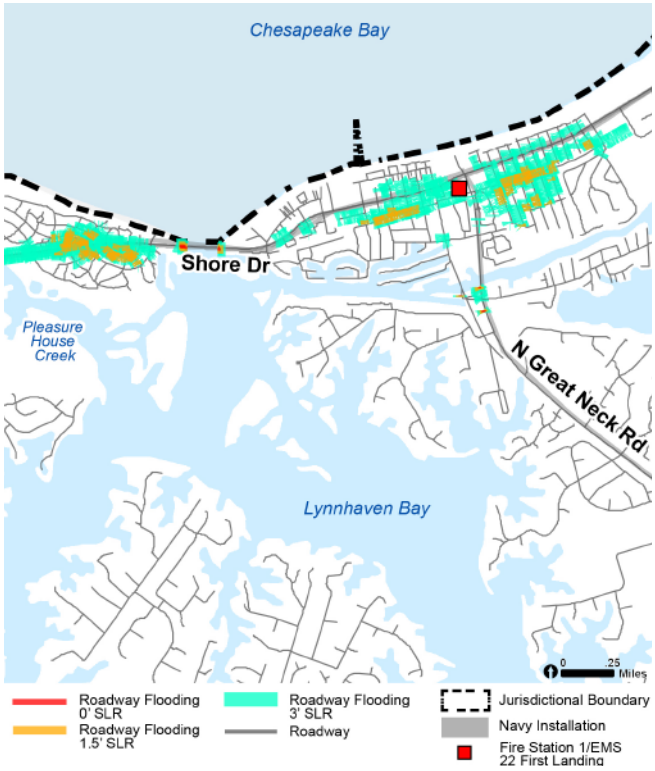


FIGURE 3-37: Action 14: Access to Community Assets

Implementation Steps

1. Virginia Beach should review existing studies, to determine if more detailed site-level analysis is needed.
2. Pursue funding for cost/benefit of adaptation strategies that address long-term SLR. Strategies could explore building adaptation measures or relocation and should consider cost/benefits.
3. Determine preferred solutions.
4. Identify phasing and pursue funding for project implementation.

Lead: Virginia Beach

Partners: N/A

Funding and Approval Status

No study has been initiated for this Action, and no funding is currently in place for the specific study. However, there may be an opportunity to analyze this site as part of the city's ongoing *Stormwater Master Plan Update* and *Sea Level Rise and Recurrent Flooding Planning Study* planning processes.

Cost Range

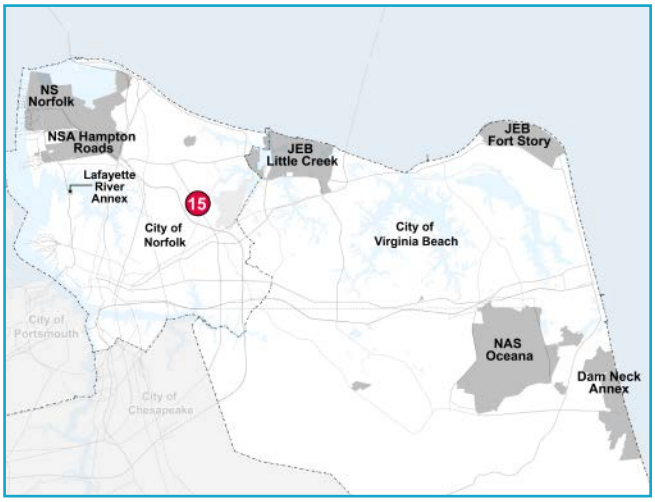
- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Virginia Beach CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)

3.2.15 Norview Avenue Drainage Study

15



This Action recommends undertaking a study of the drainage patterns along Norview Avenue to understand the cause(s) of the recurrent flooding and to identify mitigation strategies.

Action Score: 9

Installation Readiness: **0**

DoD Personnel Readiness: **4**

Co-Benefits: **1**

System Performance and Design: **4**

Norview Avenue is the primary access route for Norfolk International Airport, the major airport serving the entire southside Hampton Roads region. The airport is critical to the economy in Hampton Roads and serves as a major regional hub for both military and civilian passengers, as well as for cargo (freight and mail). According to its 2008 Master Plan, ORF serves nearly four million arriving/departing passengers and accommodates more than 68 million pounds of air cargo per year.[1] Access to the airport is important for military personnel and their families.

The Need for Action

During the stakeholder interview process, concerns were raised about recurrent flooding along Norview Avenue, particularly near Norfolk Fire and Rescue Station 14. However, the cause of the flooding (undersized stormwater infrastructure, drainage patterns particular to that area, etc.) is uncertain. This section of Norview Avenue is adjacent to a small creek that feeds into Lake Whitehurst, but that has not been determined to be the cause of the flooding. **Figure 3-38** shows the location of this action.

Flooding along Norview Avenue also impacts access to community facilities for civilian and DoD residents in the surrounding neighborhoods. These impacts could worsen with additional sea level rise, as shown in **Figure 3-39**, in future tidal flooding scenarios that could overtop the lake's weir adjacent to Little Creek Harbor.

1 *Master Plan Update: Norfolk International Airport.* Norfolk International Airport, 2008. Accessed May 6, 2019. http://www.orfmasterplan.com/resources/documents/ORFMasterPlanUpdate2008-Executive%20Summary.pdf.

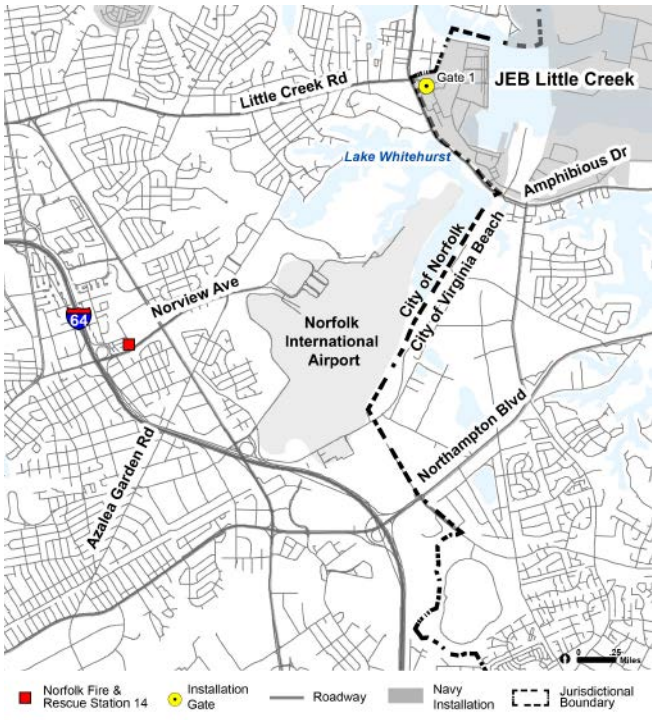


FIGURE 3-38: Action 15: Approximate Action Location

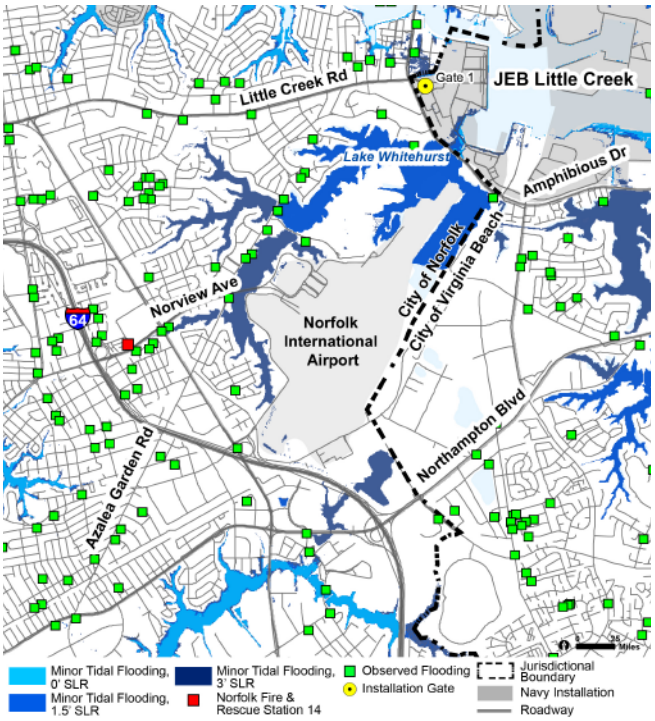


FIGURE 3-39: Action 15: Sea Level Rise Scenarios and Historical Flood Complaints

Proposed Action

This Action recommends undertaking a study of the drainage patterns along Norview Avenue to understand the cause(s) of the recurrent flooding. A better understanding of the causes of flooding in this area will help Norfolk more effectively manage stormwater drainage along the corridor. Future project design should also account for the potential impacts of additional sea level rise and management of water levels in Lake Whitehurst.

It is recommended that this project be considered in conjunction with Action #3, JEB Little Creek Gate 1 – Amphibious Drive – Shore Drive Flooding Study. This Action will require modeling of the same watershed (that leads into Lake Whitehurst), so pursing them together could maximize efficiencies (and potential cost savings) for both projects.

Action Benefits

- Could identify opportunities to improve access to the region's primary airport.
- Could identify opportunities to reduce current flood risk to the surrounding community, as well as protecting it from some of the impacts of increased sea level rise in the future.
- Could identify opportunities to ensure access to community assets along Norview Avenue that both DoD personnel and civilians rely upon, including a fire station and several elementary schools that also serve as emergency shelters.
- Could identify opportunities for incorporating green infrastructure elements.

- Could identify opportunities for increased ecological benefits. Proposed action considers future conditions, including additional sea level rise.

Implementation Steps

1. Create a working partnership between Norfolk and ORF to coordinate and oversee the study. If this action is pursued with Action #3, the partnership should also include the Navy and Virginia Beach.
2. Pursue funding for study.
3. Utilize all existing studies, watershed models, and other planning and/or design work done for this area as a baseline for this study.
4. Once causes of flooding are determined, jointly determine preferred design solutions to address flooding.
5. Identify phasing and jointly pursue funding for project implementation.
6. Define applicable operating and maintenance parameters as part of any solution.

Lead: Norfolk

Partners: Norfolk International Airport

Funding and Approval Status

- Funding sources for study are currently undetermined.
- No official study or planning work has been initiated for this Action.

Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Norfolk CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- USACE Section 205: Flood Risk Management Program
- 2018 USACE Supplemental Appropriation

3.2.16 Resilient Underpass Pump System Study

16

This Action recommends a vulnerability study of Norfolk's roadway underpass pump stations to assess their ability to withstand future sea level rise and to identify adaptation strategies.

Action Score: 9

Installation Readiness: **6**

DoD Personnel Readiness: **2**

Co-Benefits: **0**

System Performance and Design: **1**

All 11 roadway underpasses in Norfolk, several of which are on primary roadways serving the Navy, are kept clear during flooding events by electric-powered pump stations served by the power grid (Dominion Energy). These pump stations are only designed to handle a 10-year design storm. In the event of a power outage, these pump stations also rely on fuel-powered backup generators to remain operational.

The Need for Action

If roadways are impassable due to flooding, it directly impacts the ability of personnel to access the bases in a timely manner, which may be particularly critical during or immediately after a major storm event (when underpasses are also most likely to be flooded).

During the JLUS interview process, the concern was raised about the ability to keep underpasses free from flooding, and the impact it could have on diesel fuel delivery service to the Navy. While installations have back-up fuel reserves on base, in the event of an extended power outage, they may need additional diesel fuel delivered to power the back-up generators serving critical on-base facilities. As sea levels rise, underpass flooding could become more frequent and severe.

Furthermore, keeping major roadway underpasses clear is critical for emergency response, both on and off the installation, to ensure access to hospitals and emergency shelters, particularly during and immediately following major storm events.

Proposed Action

This Action recommends an evaluation of the capacity and resilience of existing underpass pump stations in Norfolk. As sea levels rise, and more intense storms become more frequent, Norfolk's underpass pump station infrastructure may struggle to keep up with the volume of water generated by both precipitation and storm surge flooding.

The recommended study would determine which underpasses/underpass pump stations are the most vulnerable to the impacts of sea level rise and increased flooding, and would explore adaptation mechanisms to make them more resilient. Adaptation strategies could include options to retrofit, raise, or rebuild the pump stations and should also consider approaches for more resilient or redundant back-up power alternatives.

This study also presents an opportunity to explore the design standards and specifications being used for Norfolk's pump stations to determine if any adjustments are needed based on the outcome of the study.

Action Benefits

- Could result in a comprehensive solution to reduce both current and future flood risk along major strategic corridors serving the DoD.
- Could result in a comprehensive solution that improves access to community assets that DoD personnel and civilians rely upon, including fire/emergency stations, hospitals, and elementary schools that also serve as emergency shelters.
- Could help promote stronger guidelines for pump station/pump infrastructure design that could serve as a regional model.

Implementation Steps

1. Form a working partnership between Norfolk and VDOT to coordinate and oversee the study.
2. Develop a scope of work for the study; utilize any available data/case studies of best practices to support study.
3. Pursue funding for the study.
4. Determine preferred actions/solutions.
5. Present preliminary baseline findings and proposed actions to the HRPDC Directors of Utilities Committee.
6. Determine need for updating design standards for underpass pump systems.
7. Pursue detailed project planning and design for funding and approvals for capital investments, considering capital, engineering, legal, property, operation, and maintenance for each strategy.[1]

Lead: Norfolk

Partners: VDOT

Funding and Approval Stages

No official planning work has been initiated for this Action, and there is no funding currently allocated for the proposed study.

Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

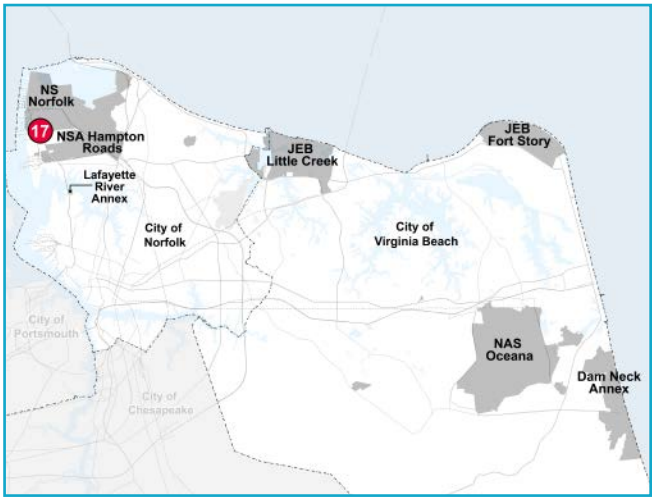
Potential Funding Sources

- Norfolk CIP Funding

1 *Hydraulic Engineering Circular No. 24 Highway Stormwater Pump Station Design*. U.S. Department of Transportation Federal Highway Administration, February 2001. Accessed May 6, 2019. https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec24.pdf.

- VA Department of Mines, Minerals, and Energy (DMME) VirginiaSAVES Green Community Program
- Virginia's Transportation Funding (VDOT, DRPT)
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loans
- U.S. DoD Community Infrastructure Program
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Hazard Mitigation Grant Program (Section 404)
- FEMA Public Assistance Grant Program (Section 406)
- FEMA Pre-Disaster Mitigation Flood Mitigation Assistance program (Section 1366)
- FHWA Defense Access Road Program

3.2.17 Elizabeth River Trail Extension 17



This Action recommends extending the Elizabeth River Trail (ERT) to NS Norfolk Gate 1, consistent with the Elizabeth River Trail Foundation's plans.

Action Score: 8

Installation Readiness: **3**

DoD Personnel Readiness: **4**

Co-Benefits: **1**

System Performance and Design: **0**

The existing ERT is a paved path dedicated to bicyclists and pedestrians that stretches 10.5 miles, from Harbor Park in downtown Norfolk to the intersection of Hampton Boulevard and Cloncurry Road, just south of NSA Hampton Roads.

The Need for Action

Hampton Boulevard is a primary corridor serving both NS Norfolk and NSA Hampton Roads. Congestion along the corridor is an ongoing issue, and is often exacerbated by recurrent roadway flooding that will continue to worsen as sea levels rise. Although the ERT may not always be a viable alternative during flood events, extending the trail along Hampton Boulevard would offer continuous connections to a regional trail system, and provide more options for personnel to get to and from the bases in an efficient manner.

While driving is expected to remain a primary mode of choice along the corridor, shifting some of the mode share to bicycling could have a modest benefit on congestion along Hampton Boulevard and on-base. It could offer an alternative and healthier option and, depending on the level of traffic congestion, a more efficient way to get to work. The mode shift could also help reduce pressure on the installations to provide space for on-base parking.

Proposed Action

This Action proposes to extend the existing ERT north along Hampton Boulevard to NS Norfolk Gate 1. This would give Navy personnel at NS Norfolk and NSA Hampton Roads an alternative form of

FIGURE 3-40: Action 17: Elizabeth River Trail, Proposed Extensions and Loops

Source: Friends of the ERT Foundation

transportation to access the installations. It would also provide a direct connection downtown to other desired amenities.

The Elizabeth River Trail Foundation has already proposed to extend the trail along this route. The Foundation is in the process of raising the funds[1] to extend and improve the trail (see **Figure 3-40**). Norfolk has allocated funding in the 2019 budget for the trail, but most of it is focused on maintaining/ improving the existing trail. In addition, the 2014 *Norfolk Bicycle and Pedestrian Strategic Plan* identifies the ERT as a key priority and identifies a citywide recreation loop that includes the ERT.[2]

The Foundation should work with Norfolk and engage the Navy in the trail design and development process to ensure that all alignment options are fully understood. This level of coordination could result in opportunities to better connect the ERT to the installations through improved wayfinding and signage.

In addition, project planning and design for the trial should be integrated with any other ongoing corridor or master plan processes that could affect stormwater infrastructure in this area, including Norfolk, NS Norfolk, NSA Hampton Roads, and Port of Virginia redevelopment projects.

Action Benefits

- Could improve access to NS Norfolk and NSA Hampton Roads by offering an alternative mode of travel to both installations.
- Could provide a safe off-road alternative between NS Norfolk and NSA Hampton Roads.
- Could help reduce dependency on personal vehicles and reduce on-base demand for parking.
- Could create expanded opportunities for recreation and physical fitness.
- Could enhance the value of the broader community.
- Could positively impact roadway congestion along the corridor.
- Could be combined with other corridor enhancements to create a more "complete" street along Hampton Boulevard.

Implementation Steps

1. Define the required level of additional planning and design for the trail extension based on available data and studies.
2. Develop working team that includes the U.S. Navy, Norfolk, and ERT Foundation to assess land and environmental suitability for trail extension along with user needs.

1 Boykin, Nick. "City of Norfolk, other investing total of $4 million in Elizabeth River Trail." Wtkr.com. April 7, 2018. https://wtkr.com/2018/04/07/city-of-norfolk-others-investing-total-of-4-million-in-elizabeth-river-trail/
2 *City* of *Norfolk Bicycle and Pedestrian Plan.* City of Norfolk, 2014.

3. Pursue funding and develop concept plans for the trail and preliminary costs for trail extension.
4. Pursue funding to complete trail design.
5. Initiate required permits and approvals.
6. Pursue funding for construction.

Other Actions along the Hampton Boulevard corridor could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest. Nearby related actions include:

- Action # 1: Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy

Lead: Norfolk; Elizabeth River Trail Foundation

Partners: U.S. Navy; Virginia Port Authority

Funding and Approvals Status

- The ERT Foundation is currently in the process of raising the funds to extend and improve the existing trail, but has not yet applied for plan approval/permits with Norfolk.
- Ten and a half miles of trail have already been built and funded. According to the Friends of the Elizabeth River Trail, $2.6 million in funding has already been raised for the trail extension, but they still need about $1.6 million in additional funding to complete the extension.[3]

Cost Range

- $$$ ($1M – $10M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

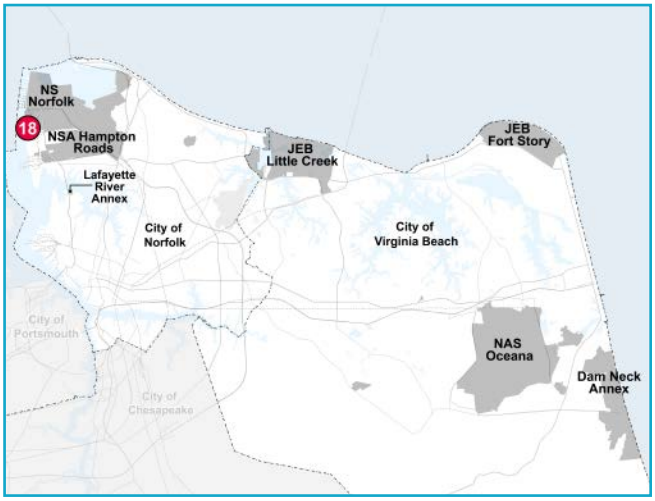
Potential Funding Sources

- Norfolk CIP Funding
- Elizabeth River Trail Foundation
- Virginia's Transportation Funding (VDOT, DRPT)
- FHWA Recreational Trails Program

3 Staff. "Major Elizabeth River Trail announcement planned." 13newsnow.com. April 6, 2018. https://www.13newsnow.com/article/news/local/mycity/norfolk/major-elizabeth-river-trail-announcement-planned/291-535845805.

3.2.18 Ferry Service Feasibility Study

18



This Action proposes to study the feasibility of extending HRT's ferry service up to NS Norfolk, to allow Navy service members living in southside Hampton Roads an alternative means of access to work.

Action Score: 8

Installation Readiness: **3**

DoD Personnel Readiness: **4**

Co-Benefits: **0**

System Performance and Design: **1**

HRT currently operates three 150-passenger ferries that travel the Elizabeth River between Norfolk and Portsmouth. All of the ferry terminals on the Norfolk side are currently located downtown, several miles south of NS Norfolk and NSA Hampton Roads.[1] Multimodal transit options currently serving the Navy installations in Norfolk and Virginia Beach are limited, and most DoD personnel drive to work and park on the installation.

The Need for Action

Many of the routes connecting Norfolk with southside Hampton Roads (Portsmouth, Suffolk, and Chesapeake) are highly congested during peak travel times. Congestion is an issue along some of the primary corridors serving the DoD. Although there are HRT bus routes that serve NS Norfolk, NSA Hampton Roads, and JEB Little Creek, service times and frequency is limited. There are few on-site HRT bus stops, and the installations have no DoD shuttle service for users of public transportation. HRT bus drivers accessing the installations must be vetted and credentialed.

Because of heavy traffic congestion at peak hours and along key corridors, ferry service could be part of a broader multi-modal strategy to provide more options for DoD personnel to get to work and could also benefit NIT. It could potentially reduce the amount of time it would take personnel who live in southside Hampton Roads to access NS Norfolk.

1 "Elizabeth River Ferry." GoHRT.com. Accessed May 6, 2019. https://gohrt.com/routes/ferry/.

Having an option for getting to work that does not rely upon congested roadways, or roadways impacted from flooding, supports military readiness.

Proposed Action

This Action recommends the pursuit of a feasibility study for extending HRT's ferry service to NS Norfolk in order to provide an alternative means of access to the base.

The feasibility study should consider cost and benefit options for siting a ferry terminal that takes into consideration security requirements, base access protocols, and processing requirements for both the Navy and NIT. The study could also outline design requirements that would need to be considered. Options for internal transportation shuttle services at both NS Norfolk and NSA Hampton Roads that consider security requirements, base access protocols, and processing requirements would also likely need to be developed to link the ferry terminal to places of work.

HRT has not yet undertaken a formal study on expanding ferry service in the region. This study could therefore be defined to include other potential ferry service locations in the region.[2]

Action Benefits

- Could identify opportunities for providing an alternative mode of access for personnel at NS Norfolk and NSA Hampton Roads.
- Could identify opportunities for increasing transit access to NIT.
- Could identify opportunities for expanding transit options for the region as a whole.
- Could identify a suitable location for a ferry terminal that considers security requirements.

Implementation Steps

1. Form a working partnership between HRT, the cities of Norfolk and Portsmouth, the Navy, and the Virginia Port Authority to coordinate and oversee the study.
2. Develop a scope of work for the feasibility study with input from project partners.
3. Use previous and ongoing regional transit studies and plans by HRT, HRTPO, and others as input to the study.
4. Pursue funding for the study.
5. Based on the results of the study, determine preferred next steps.

Lead: HRT

Partners: U.S. Navy, Virginia Port Authority, Norfolk

Funding and Approval Status

- No funding is in place for this study.
- No official planning has been initiated for this action.

Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

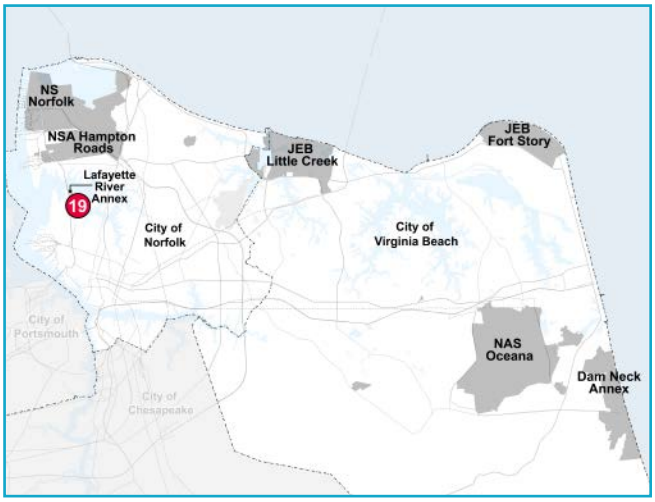
Potential Funding Sources

- Virginia's Transportation Funding (VDOT, DRPT)
- FHWA Construction of Ferry Boats and Ferry Terminal Facilities Program
- FHWA National Highway Performance Program
- FHWA Passenger Ferry Grant Program, Section 5307

2 HRT has recently explored options for extending the Norfolk Tide light rail from downtown to NS Norfolk and NSA Hampton Roads. The final report of the Norfolk Westside Transit Study in July of 2018 determined that extending the light rail in the western part of the City could be problematic; however, there is still potential for implementing a Bus Rapid Transit system in that part of the city. HRT is currently preparing to study options for an eastern alignment of the Tide light rail system.

3.2.19 Lafayette River Annex Vulnerability Study

19



This Action recommends a study to evaluate vulnerabilities for the long-term use of the Lafayette River Annex (LRA).

Action Score: 8

Installation Readiness: **3**

DoD Personnel Readiness: **4**

Co-Benefits: **0**

System Performance and Design: **1**

The LRA is part of NSA Hampton Roads. Located just south of the Hampton Boulevard Bridge, the site is surrounded by the Lafayette River on two sides, and is bordered by Hampton Boulevard on the west and Lexan Avenue on the south.

The Need for Action

The LRA is particularly vulnerable to impacts from flooding and future sea level rise. Because the installation is surrounded by the Lafayette River on two sides, it is vulnerable to both tidal flooding and precipitation flooding, which can prevent access to either or both site entrances. Much of the installation itself could be frequently inundated by minor tidal flooding with an additional 1.5 feet of sea level rise, as shown in **Figure 3-41**.

A partial sea wall currently exists along the northern end of the installation, but it is not in good repair and is therefore likely not effective in significantly reducing flood risk to the installation. Recurrent flooding on Hampton Boulevard and Lexan Avenue, which is adjacent to the entrance to LRA, is an ongoing issue and directly impacts access to and from the Annex. This is well-documented in City of Norfolk flood observation data, as shown in **Figure 3-41**.

The LRA site is non-contiguous from NSA Hampton Roads, NS Norfolk, and other related facilities and is accessible by the Hampton Boulevard corridor, which is also historically subject to flooding. Flooding conditions and future sea level rise along the Hampton Boulevard corridor will likely make reaching

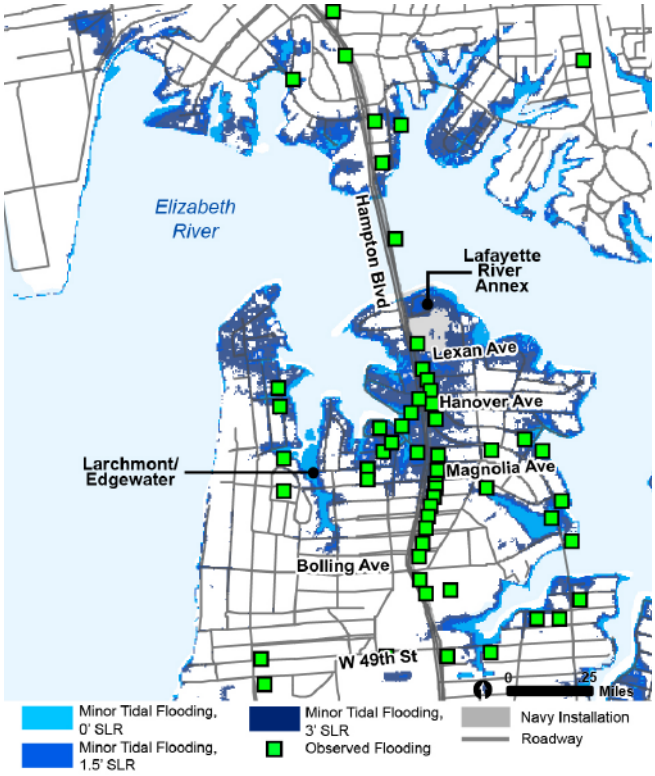


FIGURE 3-41: Action 19: Sea Level Rise Scenarios and Historical Flood Complaints

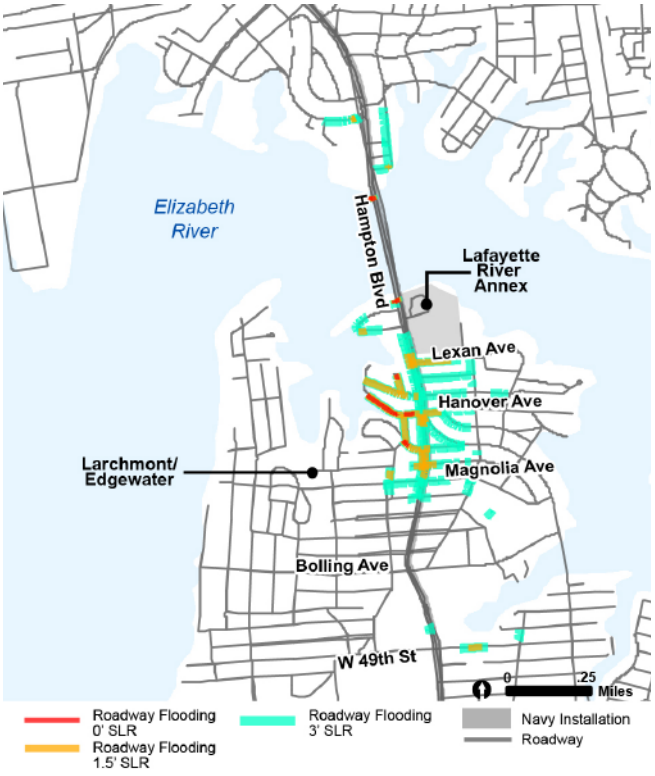


FIGURE 3-42: Action 19: Transportation Infrastructure Vulnerability

the LRA site more difficult over time, as discussed in Action #1, Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy. **Figure 3-42** shows the impacts flooding will have on roadways surrounding the LRA over time. Increasing sea level rise combined with minor tidal flooding could create serious access issues for much of the neighborhood around the LRA site, as **Figure 3-43** shows, and could cut off access to the site altogether, which would have a dramatic impact to military readiness.

Proposed Action

For these reasons, the Navy and Norfolk should partner to evaluate options now for the long-term use of this site, including the costs and benefits of required infrastructure upgrades, or options for potential relocation of the functions provided by the LRA. By pursuing the study now, the Navy and city can determine the best course of action before mission impacts become more severe or additional investments are made that cannot be recovered.

The study should be conducted in consultation with Norfolk to ensure it takes into account the city's infrastructure and any proposed upgrades. There may also be opportunities to partner for infrastructure upgrades depending on the preferred course of action.

Action Benefits

- Could identify opportunities to reduce vulnerability to the Lafayette River Annex site, a valuable DoD asset.

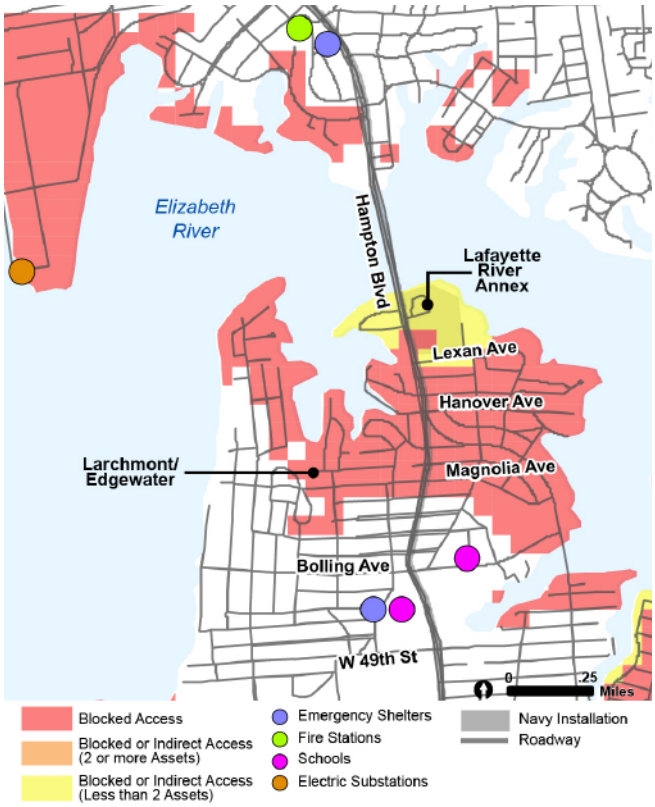


FIGURE 3-43: Action 19: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

- Could identify opportunities for the long-term sustainment of the LRA mission.
- Could provide opportunities to improve access along Lexan Avenue and adjacent neighborhoods through infrastructure upgrades.
- Considers future conditions, including additional sea level rise.

Depending on the course of action chosen in the study, other benefits beyond those identified could be realized. The LRA site is currently located in an area (zip code) with a high concentration of DoD commuters and is located along a strategic corridor. However, because the study itself is limited to the LRA site and would not address flood risk to the actual corridor, it scores lower in overall points related to installation and personnel readiness than other actions.

Implementation Steps

1. The Navy should develop a scope of work for analyzing multiple courses of action. The study should consider potentially relocating the Annex to higher ground and the costs/benefits should be compared to options for making improvements to the installation in situ to address current and long-term flooding impacts from sea level rise. The study should examine the feasibility of elevating and/or floodproofing structures on the installation, including building ring walls around historical structures, if modifying the structures themselves is not feasible.

   The study could also consider options for incorporating stormwater storage capacity on site to contain runoff and reduce ponding on the property, particularly when tidal conditions hinder drainage. For example, capacity could be added as subsurface storage under the existing parking area.

2. Include other studies and/or plans completed in this area, such as Norfolk's 2016 *Hampton Boulevard Drainage Study.*

3. Coordinate with Norfolk and the USACE to ensure that the USACE recommended project for an Outer Surge Barrier on the Lafayette River is taken into account. The barrier would significantly alter the LRA site's vulnerability to moderate and extreme storm surges (see Action #5).

Other Actions along the Hampton Boulevard corridor could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest. Nearby related actions include:

- Action #1: Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy
- Action #5: Lafayette River Outer Surge Barrier (USACE)

Lead: U.S. Navy

Partner: Norfolk

Funding and Approval Status

- No funding is in place for this study.
- No official planning has been initiated for this action.

As the study is pursued, an effort should be made to ensure project planning and design is integrated with any other ongoing corridor or master plan processes that could affect stormwater infrastructure in this area.

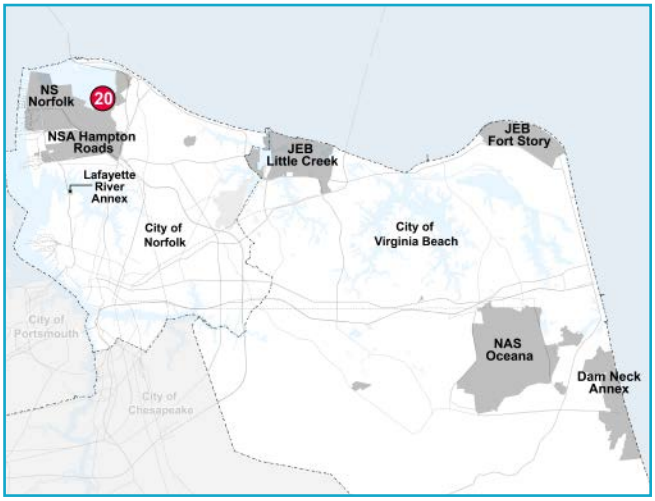
Cost Range

- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Norfolk CIP Funding
- VA DCR Dam Safety and Floodplain Management Grants
- VA DEQ Stormwater Local Assistance Fund
- VA DEQ Stormwater Loan
- U.S. Navy Funding
- U.S. DoD OEA Implementation Grants

3.2.20 Mason Creek Flood Mitigation Strategy 20



This Action would establish a comprehensive strategy for upgrading stormwater management and mitigating flood risk in the Mason Creek watershed.

Action Score: 8

Installation Readiness: **3**

DoD Personnel Readiness: **2**

Co-Benefits: **1**

System Performance and Design: **2**

The existing Mason Creek tide gate, located on the northeast side of NS Norfolk, is designed to help control water levels in Mason Creek when water levels in the Chesapeake Bay are high due to tides and/or precipitation from storm events.

The Need for Action

High water levels in Mason Creek currently cause recurrent flooding on roadways and properties in the surrounding neighborhoods. These neighborhoods are home to both military personnel and civilians, and recurrent flooding in the neighborhoods can make it difficult for residents to get to work, and can also impede access to critical community assets such as emergency shelters, elementary schools, and hospitals. As shown in **Figure 3-44**, these issues will worsen as sea levels rise, and flood complaints are already well-documented in the area.

Although the current Mason Creek tide gate is effective for keeping tidal surge from Willoughby Bay from inundating Mason Creek, the mechanism that allows runoff to flow out of Mason Creek when the gate is closed due to high tidal water levels could potentially be made more efficient. With additional sea level rise, higher daily tide levels in Mason Creek will reduce the creek's capacity to receive and store runoff below levels that cause property flooding. Higher sea levels will also increase the frequency of gate closures under the current operating criteria. Unless provisions are made to provide additional stormwater storage/additional capacity to convey stormwater out of Mason Creek to Willoughby Bay, additional sea level rise will result in greater frequency and depth of property and street flooding in the

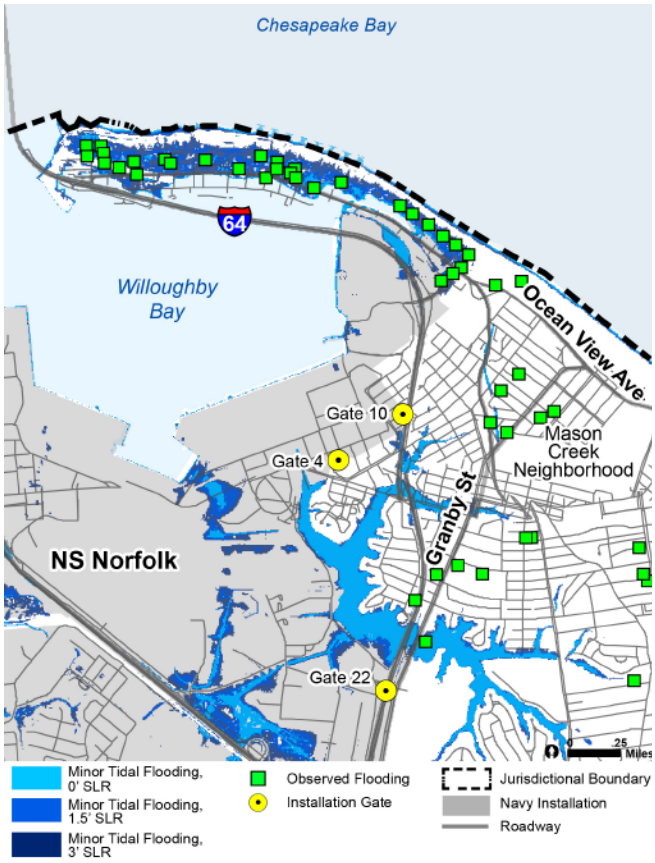


FIGURE 3-44: Action 20: Sea Level Rise Scenarios and Historical Flood Complaints

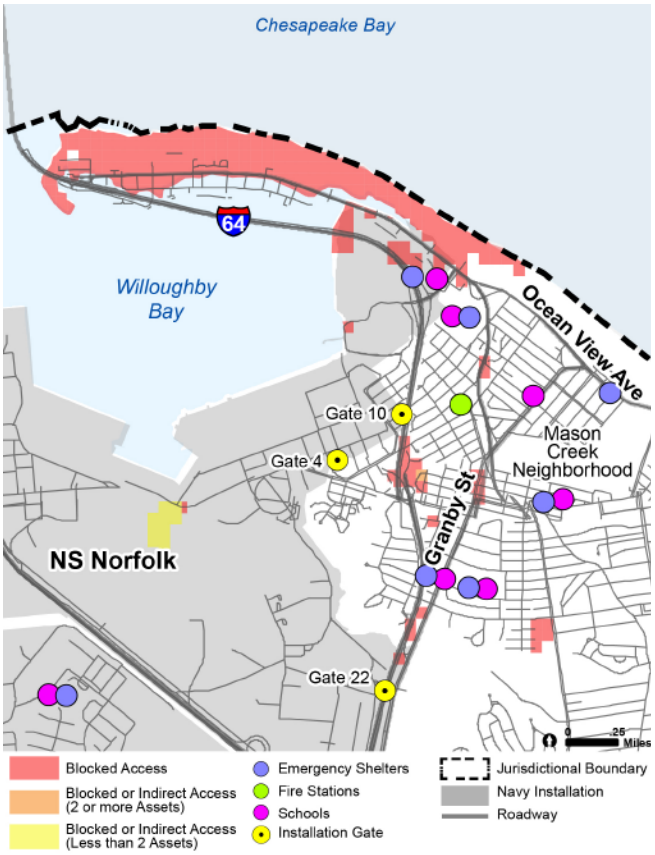


FIGURE 3-45: Action 20: Access to Community Assets under Minor Tidal Flooding with 3.0 feet of SLR

adjacent community and at locations on NS Norfolk. **Figure 3-45** shows potential impacts on neighborhood access surrounding Mason Creek with 3.0 additional feet of sea level rise.

Proposed Action

This Action proposes developing a stormwater management strategy to address recurrent flooding from tidal and precipitation events. The strategy should consider structural upgrades to the current tide gate in order to address precipitation-driven water level increases in Mason Creek when the gate is closed.

Because the current tide gate is located on the installation, it is operated by Navy staff, according to a Memorandum of Understanding (MOU) established between the Navy and Norfolk. Because of coordination between Norfolk public works staff and NS Norfolk, operations have historically been successful at mitigating tidal flooding in Mason Creek. However, when the gate is closed to prevent tidal flooding, rainfall runoff can back up in the creek behind the gate, causing flooding on some properties in the residential community. This Action is an opportunity for the Navy to partner with Norfolk to address a current issue, which will occur more frequently and become more problematic and challenging as sea level rise occurs.

Improvements to the existing tide gate should allow the rainfall runoff that accumulates in Mason Creek when the tide gate is closed to flow out more efficiently. A pump station, to manage the Mason

Creek water level prior to and during severe rainfall events in which the tide gate is closed, should also be considered. Dredging Mason Creek, in combination with pumping, would allow for greater rainfall runoff storage capacity before yard and street flooding levels are reached, and would also allow for aeration devices to be installed to improve water and sediment quality in Mason Creek. A dredging and aeration design has been permitted by Norfolk, which would contribute to a pumping infrastructure solution, but funding has not yet been allocated for construction.

Much of the design study and modeling for this action could be supported by work already completed by Norfolk. This Action should also utilize any prior stormwater modeling done for NS Norfolk.

Action Benefits

- Could identify opportunities to reduce risk of on-base flooding under future sea level rise scenarios.
- Could identify opportunities to improve access to community facilities that DoD personnel and residents of the Mason Creek neighborhood (and surrounding areas) rely upon.
- Could identify opportunities to reduce current flood risk to roadways and property and protect them from some of the impacts of increased sea level rise in the future.
- Considers future conditions, including additional sea level rise.

Implementation Steps

1. Form a close working partnership between the Navy and Norfolk for planning, designing, and implementing this action.
2. Utilize existing studies and watershed modeling already done in this area as a baseline for developing this strategy.
3. Pursue funding for further study, planning, and design.
4. Jointly determine preferred design solutions to meet project goals.
5. Identify phasing and jointly pursue funding for project implementation.
6. Define applicable operating and maintenance parameters as part of any solution.

Other actions in this area could be pursued in conjunction with this strategy depending on available funding, staff resources, and interest, including Action #13: Willoughby Bay Shoreline Floodwall Options.

Lead: Norfolk

Partner: U.S. Navy

Funding and Approval Status

- No funding is in place for this study.
- Although prior watershed/stormwater modeling has been done for this general area, no official planning or design work has been initiated for this specific Action. Concept designs for tide gate operations and a pumping station are well-documented, which should allow the project to move into a more detailed engineering phase without significant additional study, if funded.

Cost Range

- $$$$ ($10M – $25M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

- VA DCR Dam Safety and Floodplain Management Grants
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- USACE Section 205: Flood Risk Management Program

3.2.21 Wastewater Treatment Plant Vulnerability Assessments

21

This Action proposes initiating a detailed vulnerability assessment of Norfolk's water treatment plants and HRSD's wastewater treatment plants to determine future access and flooding impacts, and explore options for addressing them.

Action Score: 8

Installation Readiness: **3**

DoD Personnel Readiness: **2**

Co-Benefits: **1**

System Performance and Design: **2**

There are four wastewater treatment plants currently located in the JLUS study area. The wastewater treatment plants are owned and operated by HRSD. The overall wastewater treatment system relies upon a series of sanitary pump stations that are owned and maintained by HRSD, Norfolk, and Virginia Beach.[1]

The Need for Action

The U.S. Navy relies upon HRSD, Norfolk, and Virginia Beach to provide wastewater services. The Community Asset Exposure analysis shows the Virginia Initiative and Army Base wastewater treatment plant could potentially be impacted by minor tidal flooding under current conditions (0 feet of SLR) and will become increasingly vulnerable as sea levels rise, as **Table 3-3** shows. All wastewater treatment plants in the study area could potentially be impacted by an additional 3.0 feet of sea level rise, which could occur as early as 2065. Both the Navy and the community rely on these treatment plants for wastewater treatment. Impacts from flooding and sea

TABLE 3-3: WASTEWATER TREATMENT PLANT EXPOSURE

		EXPOSURE		
FACILITY	CITY	0' SLR	1.5' SLR	3.0 FEET OF SLR
VIP / Virginia Initiative	Norfolk	yes	yes	yes
AB / Army Base	Norfolk	yes	yes	yes
AT / Atlantic	Virginia Beach	no	no	yes

1 Chapter 2 discusses wastewater utility services in more detail.

level rise could significantly compromise military mission readiness and endanger the health, safety, and welfare of all Hampton Roads residents.

Additional sea level rise could impact these treatment facilities in multiple ways. Roadway flooding could impact the ability of both HRSD and the localities to access system infrastructure for repair and maintenance, which would be particularly critical if any of those facilities were damaged during a major storm event. Sea level rise could also inundate the plants themselves, overwhelming pipes and tanks and leading to system failure.

In 2017, HRSD issued an *Integrated Plan/Regional Wet Weather Management Plan* (RWWMP), which identifies projects to enhance the capacity of the regional system and reduce the occurrence of sanitary sewer overflows during storm events, when flooding can overwhelm sewer infrastructure. The integrated plan also considers the additional impacts of sea level rise and land subsidence on critical wastewater treatment infrastructure. Additionally, HRSD's design standards require freeboard for new HRSD structures built in Norfolk and Virginia Beach. For Norfolk, HRSD requires that HRSD structures built in the floodplain be elevated to base flood elevation plus 3 feet of freeboard; in Virginia Beach, HRSD requires that HRSD structures be elevated to base flood elevation plus 2 feet of freeboard.[2] HRSD is also planning to conduct a study assessing the resilience of its infrastructure to flooding and sea level rise, which would be consistent with this Action.[3]

Proposed Action

This Action proposes building on the work that HRSD is already doing to protect critical wastewater infrastructure from the impacts of flooding and sea level rise by initiating a detailed vulnerability assessment of wastewater treatment plants by HRSD, in partnership with Norfolk and Virginia Beach. The study should determine the baseline risk to the treatment plants and take into consideration storm surge risk, as well as potential environmental impacts. Available stormwater data and modeling from both localities should be leveraged for this study. The assessment should consider access routes and potential impacts to all critical wastewater and sanitary sewer infrastructure serving the plants, including lift and pump stations, and other components that could be affected under the various flooding and sea level rise scenarios.

The assessment should also aim to determine how adaptable the infrastructure is to future flood conditions and what level of investment would be required, based on the acceptable level of risk. Future improvements should be designed to accommodate increased levels of flooding.

Action Benefits

- Could identify opportunities to protect military mission readiness and the health, safety, and welfare of citizens.
- Could identify opportunities to reduce future disruption to sanitary sewer service due to storm events and SLR.
- Could identify opportunities for understanding the potential investment required to address identified vulnerabilities so that appropriate capital investment plans can be made.
- Could identify opportunities to mitigate flood risk to critical routes that provide direct access to wastewater treatment plants and sanitary sewer pump stations.

Implementation Steps

1. Form a working partnership between HRSD and the cities of Norfolk and Virginia Beach to coordinate and oversee the study.

2 *HRSD Design and Construction Standards*. Hampton Roads Sanitation District, January 2018.
3 Per email from Rob Martz with HRSD, received April 8, 2019

2. Develop scope of work for study; utilize available modeling data from localities to support study.
3. Pursue funding for the study.
4. Determine preferred actions/solutions to mitigate current and future risks to wastewater treatment plants and infrastructure.
5. Pursue detailed project planning and design for funding and approvals for capital investments, considering capital, engineering, legal, property, operation, and maintenance for each strategy.

Lead: HRSD

Partners: Norfolk, Virginia Beach

Funding and Approval Status

HRSD is gearing up to conduct a study assessing the resilience of its infrastructure to flooding and sea level rise.[4] No funding has been allocated or official planning work initiated for the additional recommended steps in this Action.

Cost Range

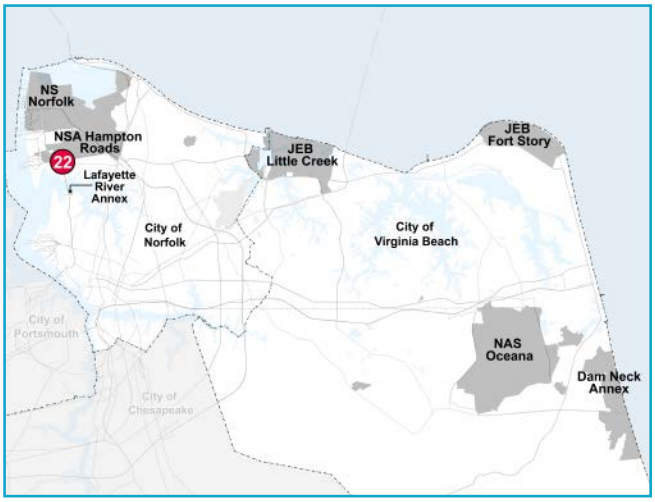
- $ ($100 – $500K)
- Defined cost range attempts to reflect the potential cost of a more detailed study of this Action

Potential Funding Sources

- Norfolk CIP Funding
- U.S. DoD Community Infrastructure Program
- FEMA National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)
- FEMA Flood Mitigation Assistance program (Section 1366)
- HRSD Capital Improvement Program
- U.S. EPA National Wetland Program Development
- U.S. EPA Clean Water Act Nonpoint Source Grant (Section 319 Grants)

4 Per email from Rob Martz with HRSD, received April 8, 2019

3.2.22 Terminal Boulevard Rail and Roadway Grade Separation 22



This Action recommends proceeding with the proposed HRTPO *2040 Long-Range Transportation Plan* (LRTP) project to construct a new rail underpass at the intersection of Terminal Boulevard and Hampton Boulevard.

Action Score: 7

Installation Readiness: **3**

DoD Personnel Readiness: **4**

Co-Benefits: **0**

System Performance and Design: **0**

Hampton Boulevard is a major north-south roadway in Norfolk that links major economic engines for the region, including downtown Norfolk, NS Norfolk, NSA Hampton Roads, and NIT. This corridor provides direct access from downtown Norfolk and the Midtown Tunnel Area to critical DOD assets, and is a primary route to connect NS Norfolk to Special Area Craney Island Fuel Depot to the west and LRA to the south.

Terminal Boulevard, also a primary corridor serving the DoD, connects the installations with Interstate 64 and the Hampton Roads Bridge Tunnel. The at-grade railway crossing leading to NIT, at the intersection of Terminal Boulevard and Hampton Boulevard, often contributes to traffic congestion and delays on Hampton Boulevard. **Figure 3-46** shows the location of the proposed project.

The Need for Action

Congestion along the heavily traveled Hampton Boulevard corridor is a current, on-going issue. Between 10 and 15 trains going to NIT cross the Hampton Boulevard and Terminal Boulevard intersection per day, according to the 2015 *Master Rail Plan for the Port of Virginia*.[1] Because the rail crossing is at-grade, vehicular traffic heading to NIT NSA Hampton Roads, and/or NS Norfolk must stop and wait for the train to cross. This significantly impedes traffic flow.

1 *2065 Master Rail Plan for the Port of Virginia.* The Port of Virginia, 2015.

FIGURE 3-46: Action 22: Approximate Location

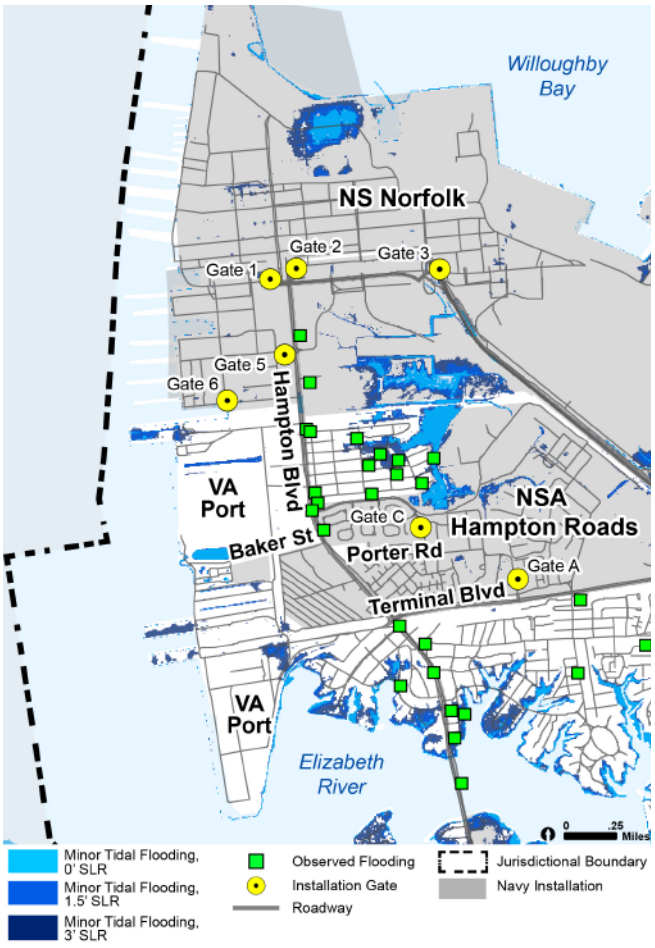


FIGURE 3-47: Action 22: Sea Level Rise Scenarios and Historical Flood Complaints

This segment of Hampton Boulevard does experience flooding impacts from surge events and heavy rainfall. **Figure 3-47** shows the history of observed flood complaints in the vicinity. The stormwater management infrastructure in this segment is owned and maintained by Norfolk, the Navy, and the Virginia Port Authority.

Proposed Action

The HRTPO identifies the need for separating the rail grade at this location as regionally significant. It is included in the *2040 Long-Range Transportation Plan*. The project would potentially greatly reduce the congestion and delays caused by trains crossing Hampton Boulevard on their way to NIT. The proposed grade separation would result in a rail underpass and would allow for unimpeded traffic flow. This improvement would improve access for all military personnel transiting the Hampton Boulevard corridor. The upgrade would expedite access to the interstate and to the rest of the city and region.

Project planning and design should be coordinated with the U.S. Navy since the intersection is adjacent to the Navy Supply Depot Annex property. The Navy is in the process of evaluating redevelopment options for that site. In addition, any other ongoing corridor or master plan processes that could affect stormwater

infrastructure in this area, including Norfolk, NS Norfolk, NSA Hampton Roads, and Virginia Port Authority redevelopment projects associated with NIT/the Port of Virginia should be fully understood and considered. JLUS Action # 6 recommends the development of a comprehensive flood mitigation and stormwater management strategy for the northern segment of Hampton Boulevard. The design for the new underpass and grade separation should take into considerations impacts on stormwater and identify opportunities for upgrading the overall system capacity and performance. The design of the underpass may require a pump system to mitigate against flooding; the design should consider storm surge impacts and future sea level rise.

Action Benefits

- Could improve access to NS Norfolk and NSA Hampton Roads by reducing congestion and delays.
- Could create opportunities to enhance stormwater infrastructure system performance.
- Could create opportunities to consider future conditions, including additional sea level rise.

Implementation Steps

1. Establish a project planning coordinating committee that includes the U.S. Navy.
2. Complete planning and NEPA requirements that are already underway.
3. Continue preliminary engineering studies that are already underway.
4. Ensure that all required plans and permits have been approved by the necessary entities.
5. Secure approvals for preferred design.
6. Pursue funding for construction.

Lead: HRTPO

Partners: Norfolk, VDOT, U.S. Navy, Virginia Port Authority

Funding and Approval Status

- The NEPA review process for this project is currently underway, and preliminary engineering has begun.[2]
- Construction funding has not been appropriated. The total estimated cost for the project is $132M.

Cost Range

- $$$$$ (> $50M)
- Defined cost range attempts to reflect the potential cost for more detailed study, design, and construction of this Action

Potential Funding Sources

The funding sources listed are noted in the LRTP.

- Hampton Roads Transportation Fund Revenue Bonds
- Virginia's Transportation Funding (VDOT, DRPT)
- U.S. DOT National Infrastructure Investments-BUILD Transportation Planning Grants
- FHWA Transportation Alternatives Set-Aside
- FHWA Defense Access Road Program
- FHWA Congestion Mitigation and Air Quality Improvement Program

2 *2040 Long-Range Transportation Plan Project Information Guide.* Hampton Roads Transportation Planning Organization, June 2016 (revised April 2017).

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4 REGIONAL COORDINATION STRATEGIES

A common theme that emerged out of the JLUS stakeholder interviews was the need for regional solutions, cooperation, and coordinated execution to address issues related to flooding and sea level rise. The need for effective and strategic collaboration among the JLUS partners is critical, but also challenging: effective regional action requires coordination among federal, state, and local government agencies and the private sector.

In addition to the Actions described in the previous chapter, the JLUS recommends **23** regional coordination strategies to institutionalize collaboration and coordination among the JLUS partners. These strategies, described in this section, can be pursued to improve or expand coordination, promote consistency and enable progress toward a regional framework for addressing sea level rise and flooding across jurisdictions. Good examples of effective collaboration already do exist, and those efforts can serve as models moving forward. Where relevant, these strategies have expanded upon best practices already in place locally, or in communities facing similar challenges.

Each strategy included in this chapter was designated as a high priority by the JLUS Technical and Policy Committees. Additional strategies that were discussed but were not identified as high priority or were outside the scope of this study are included in the Appendix. The proposed implementation strategy for the JLUS recommendations is discussed in Chapter 6.

Regional coordination strategies are presented in the following categories:

- Coordination and Outreach
- Advocacy
- Policy / Development Regulations
- Technology and Data

4.1 COORDINATION AND OUTREACH

During JLUS stakeholder interviews, improving regional coordination in the execution of strategies to address issues related to flooding and sea level rise was repeatedly raised as an important issue. Collaboration at the city department staff level with the Navy was described generally as positive, but that there was room for improvement. In most cases, collaboration that occurs today is driven by project-specific needs of each locality or the Navy, and not a regional set of common priorities. Routine leadership changes occur with the Navy and elected officials and can create challenges for continuity.

Coordination and outreach strategies are largely targeted at increasing, strengthening, and formalizing coordination and communication between the JLUS partners, other regional stakeholders, and the public. Since the 2005 *Hampton Roads Joint Land Use Study,* which focused on reducing incompatible development around the NS Norfolk Chambers Field, NAS Oceana, and Naval Auxiliary Landing Field Fentress, Virginia Beach and the Navy have been working closely on issues related to land use and development. These efforts have strengthened

relationships, and are having a lasting effect on protecting the mission at NAS Oceana. Additionally, Norfolk recently appointed a Military Affairs Liaison that reports directly to the City Manager. The creation of this position has helped Norfolk improve and formalize its communication with the Navy through a single point of contact, who can share information and facilitate decision-making on issues that may affect both parties. Since the 2005 JLUS, the Navy has also established Community Plan and Liaison (CPLO) positions at each of the installations involved in this JLUS. These examples, along with others related to shared service arrangements (utilities, fire, etc.), represent a strong foundation upon which to build a more formalized platform for working together.

Memorandums of Understanding (MOUs)

The JLUS partners should develop an MOU to formalize their commitment to intergovernmental coordination and working together to advance JLUS priorities. The MOU should formalize the coordination mechanisms between Norfolk, Virginia Beach, the HRPDC, and the Navy, and include language for establishing a JLUS implementation committee that is charged with advancing priority JLUS actions and monitoring their progress. The implementation committee could be charged with identifying project partnering opportunities and potential funding sources for actions, and coordinating with other ongoing projects. Members of the JLUS Technical Committee could transition to the committee responsible for monitoring progress. The JLUS implementation committee should coordinate with various regional boards and committees. The MOU and implementation committee should be modeled after the HRPDC regional stormwater management program. A copy of the regional stormwater MOU is included in the Appendix.

To help address inconsistent stormwater infrastructure maintenance regimens and improve performance of the overall stormwater management system, MOUs could be developed that define ongoing roles and responsibilities for routine maintenance of ditches, culverts, and other drainage components that are part of a connected system. The Navy's ability to perform routine maintenance on stormwater management systems is limited, and the cities may be able to share resources, staff, or equipment to ensure the systems function as designed. The agreements could be unique to each installation based on existing infrastructure, and would need to consider any special access or easement requirements. The Navy and cities have other cooperative agreements in place for providing fire, police, and rescue services that could be a resource for developing an MOU.

Regular Briefings

Expanded communication efforts that leverage existing mechanisms are an effective way to share information about planned infrastructure upgrades and priorities, especially those related to flood mitigation and adapting to sea level rise. Utility providers (both public and private) and the Navy should be asked to identify points of contact, and utilize them to disseminate information more widely among these entities. This would help improve basic project coordination and ensure that communication protocols function during emergencies.

Outreach to the Community

Many sailors in Hampton Roads relocate to the region from other places, meaning they are unfamiliar with Hampton Roads flooding challenges. Deployments also cause unique challenges for servicemen and women. In many cases, households are separated, while in others, possessions and residences are left unattended. As a result, personnel and their families have unique needs and vulnerabilities that can be addressed through local programs and policies that include outreach.

TABLE 4-1: COORDINATION AND OUTREACH STRATEGIES

COORDINATION AND OUTREACH STRATEGIES	LEAD RESPONSIBLE PARTY
Adopt a Memorandum of Understanding among JLUS partners to commit to working together to advance and implement JLUS priorities and establish a JLUS Implementation Committee as an outcome of the MOU.	HRPDC
Coordinate on Navy access control point (gates) projects and establish Navy policy to consider transit as part of new and redesigned gate access projects.	U.S. Navy
Develop a stormwater systems maintenance MOU for each installation and respective locality to define ongoing roles and responsibilities for routine maintenance of ditches, culverts, and other drainage components that span locality/ Navy jurisdiction.	HRPDC
Encourage utility providers to provide regular updates on infrastructure upgrades. Define clear communication protocols and points of contact between local utilities, private providers (Dominion, VA Natural Gas), and the Navy to improve coordination on projects and expedite action during emergency events.	HRPDC
Establish coordination protocols between city floodplain managers and Navy support personnel to share information about flood risk, flood insurance, existing city programs, and floodplain development regulations.	Cities
Develop outreach materials for DoD personnel about the flood risks in the area; incorporate into Navy briefings to families; disseminate through Fleet and Family Services (target military spouses).	U.S. Navy
Update the *Military Commuter Survey* (HRTPO) to address issues related to flooding and sea level rise and how these issues affect overall access to work and other services.	HRTPO

Local floodplain managers in each city should coordinate with Navy support personnel to provide information about the risks of renting or purchasing property in flood-prone or repetitively flooded structures, or in areas that currently flood regularly. Floodplain managers could also provide appropriate information on purchasing flood insurance for owners, renters, buildings, and contents.

The HRTPO's *Military Commuter Survey* should be updated to include questions about impacts experienced due to flooding. The region-wide commuter survey collects information about the commuting experience of military personnel traveling to and from the region's military bases,[1] and could be used to better understand how flooding impacts specific routes used to get to work at an installation.

The cities should inform the Navy about projects, such as roadway closures, etc., that are happening near the base, and the potential impacts they will have on daily commutes. Infrastructure or redevelopment projects can result in traffic congestion or other impacts. Timely and recurring information about upcoming and ongoing projects can help personnel plan accordingly. Likewise, the Navy should

1 *Hampton Roads Military Transportation Needs Study Military Commuter Survey.* Hampton Roads Transportation Planning Organization, September 2012.

TABLE 4-2: ADVOCACY STRATEGIES

ADVOCACY STRATEGIES	LEAD RESPONSIBLE PARTY
Encourage Congress to appropriate funding for the Defense Community Infrastructure Program (DCIP).	JLUS Partners
Encourage the DoD to require that proposed projects be identified in a JLUS to be eligible for DCIP funding, and to use criteria consistent with this study's methodology to evaluate candidate projects.	HRPDC
Pursue an amendment to the VDOT SMART SCALE criteria to include sea level rise, flooding, and military readiness as factors for prioritizing projects for funding.	HRTPO
Pursue an amendment to the Code of Virginia and the Virginia Residential Property Disclosure Act for mandatory disclosure requirements for flood hazard for real estate transactions (purchase and rental).	HRPDC

coordinate and share information with both cities about potential changes to gate access. Such changes should take into consideration stormwater management infrastructure and consider opportunities to accommodate future transit. Coordination and outreach strategies are listed in **Table 4-1.**

4.2 ADVOCACY

Strategies in this category are outward-facing, and are directed at lawmakers with the intent to meaningfully influence action at the state, federal, and regional levels in support of JLUS priorities. Advocacy efforts should aim to unify and mobilize organizations like the HRMFFA, the HRPDC, the HRTPO, Chamber of Commerce and others, in coordination with Norfolk and Virginia Beach, to petition lawmakers to consider, or require, sea level rise, flooding, and military readiness as factors for funding eligibility for program funding. This process should establish lines of communication with Virginia's U.S. Congressional delegation, representatives in the Virginia House of Delegates and Senate, and the Chief Resiliency Officer for Virginia. Advocacy strategies are listed in **Table 4-2.**

Federal Funding

A unified and coordinated message about the JLUS priorities, and their role in supporting military readiness, should be developed and used to advocate for increased funding at both the state and federal levels, including the recently authorized Defense Community Infrastructure Program[2] (DCIP). Because the DCIP is still being developed, and funding has not yet been appropriated, there is an opportunity to advocate for funding criteria that are consistent with those used in the JLUS which would strongly position Norfolk and Virginia Beach to potentially receive funding, when it becomes available.

State Funding

Changes to the VDOT SMART SCALE evaluation measures should be pursued that promote a more resilient transportation system by requiring that sea level rise, flooding, and military readiness be considered as core factors for funding eligibility. The purpose of SMART SCALE is to fund the right transportation projects through a prioritization process that evaluates each project's merits using multiple key factors, which include: improvements to

2 National Defense Authorization Act, H.R. 5515 (2019). https://www.congress.gov/115/bills/hr5515/BILLS-115hr5515enr.pdf.

safety, congestion reduction, accessibility, land use, economic development, and the environment.[3] Currently, SMART SCALE does not consider flooding or resiliency in prioritizing projects. The HRTPO *Military Transportation Needs Study* recommends the following related to roadways vulnerable to flooding:[4]

- The HRTPO should consider relative sea level rise and potential storm surge impacts when selecting future transportation projects.
- VDOT and cities should consider the latest projections for relative sea level rise/storm surge when a roadway project is designed.

Flood Risk Disclosure

An advocacy campaign is also needed to address a gap in Virginia's Code related to property disclosure for flood hazards. Requiring detailed disclosure requirements for real estate purchase and rental transactions would provide a reliable means of communicating flood risk to those seeking a home in the JLUS study area. The JLUS study area has a high concentration of transient military personnel, many of whom are new to the Hampton Roads area and are unfamiliar with the flood risk associated with specific structures, neighborhoods, and transportation corridors. Providing flood risk information to aid Navy personnel in making more informed decisions about where to live could help reduce flood risk and the impacts of flooding on sailors and their families. This would reduce risks to military operations and readiness, in addition to significantly improving quality of life for Navy personnel and dependents. Specific recommendations for changes to Virginia's property disclosure laws are listed below.

1. Amend the Virginia Residential Property Disclosure Act to require that the seller or seller's real estate agency provide detailed disclosure of flood risk information and a property's flood history.
2. Amend the Virginia Residential Landlord and Tenant Act to require that landlords disclose flood risk information and a property's flood history.

Example flood disclosure forms from Delaware, Florida, and North Carolina are included in the Appendix.

4.3 POLICY/DEVELOPMENT REGULATIONS

Land use and development regulations are an important component of long-term community resilience and directly affect the ability of a local government to protect public safety before, during, and after flood events. The strength and efficacy of such policies and regulations in the JLUS study area can have an impact on all those living and working in the communities, including military personnel and their families. Policy and development regulation strategies are listed in **Table 4-3.**

A focus of this JLUS has been to understand the impacts on Navy personnel and facilities from regulations that specifically govern stormwater management, flood hazards in new and existing development, and requirements for how infrastructure is designed and built. Municipal development regulations have a direct impact on local neighborhoods and infrastructure that provide direct or indirect services to military personnel where they live, or to the installations where they work.

One of the key challenges for Norfolk, Virginia Beach, and other Hampton Roads communities is the significant number of residential structures built

3 *Smart Scale Technical Guide*. Virginia Smart Scale, November 2017. Accessed May 6, 2019. http://vasmartscale.org/documents/20171115/ss_technical_guide_nov13_2017.pdf.
4 *Hampton Roads Military Transportation Needs Study 2018 Update*. Hampton Roads Transportation Planning Organization, July 2018.

TABLE 4-3: POLICY/DEVELOPMENT REGULATION

POLICY/DEVELOPMENT REGULATION STRATEGIES	LEAD RESPONSIBLE PARTY
Adopt the recommended regional policy for incorporating sea level rise into planning and engineering decisions, or similar policy.	Cities
Implement a cumulative substantial improvement provision for tracking improvements to structures in the flood hazard area over a pre-determined period, such as 5 or 10 years.	Cities
Strengthen repetitive loss definitions in local floodplain management ordinances to provide added protections to insured property owners.	Cities
Require a recorded declaration of land restriction to disclose flood risk location information and to highlight the prohibition of converting areas under elevated structures to habitable space.	Cities
Develop regional guidance for incorporating flooding and SLR into city capital planning projects to ensure that all projects adequately address flooding and sea level rise vulnerability, risk, and adaptation.	HRPDC
Request that state agencies incorporate Hampton Roads regional guidance, or similar policy, for flooding and SLR into all state-level capital planning projects and studies.	HRPDC
Continue to update and revise Comprehensive Plans, Zoning Ordinances, and variance requirements to align land use, density, height restrictions, open space requirements, setbacks, and other building restrictions to limit density of future development or post-disaster redevelopment in areas where flood risk is highest now and in the future.	Cities
Consider risks associated with flooding and SLR as part of any Comprehensive or area plan update and evaluate options to address those neighborhoods where access to community assets could be affected by flooding and SLR.	Cities

before the implementation of the National Flood Insurance Program (NFIP).[5] As a result, many properties in low-lying, flood-prone areas are at a higher risk of flood damage, because lowest floors and other vulnerable components are not elevated high enough to be protected. Local regulations help determine under what circumstances, and to what extent, residential properties are brought into compliance with current standards. Adopting more stringent requirements can increase the rate at which this occurs. Over the long term, there would be a measurable increase in both the quantity and market value of flood-safe housing for Navy personnel. By triggering elevation and protection of flood-prone nonconforming structures, specific new measures would make the housing stock in the JLUS study area less prone to inundation. Making the overall housing stock more resilient to flooding will improve the quality of life for Navy personnel and their families. Some common approaches localities can take to make their floodplain management programs more resilient include:

5 Norfolk joined the NFIP in 1979 and Virginia Beach joined in 1971.

- Amend floodplain management ordinances to require that older homes comply with new design standards and that new construction is more resilient.
- Require recorded declarations of land restrictions for properties in floodplains.
- Adopt design requirements for public infrastructure and facilities that account for recurrent flooding and sea level rise.

Floodplain Management

The strategies outlined in this section identify opportunities to strengthen regulations related to floodplain management. They are focused on nonconforming structures, provisions for cumulative substantial improvements, and repetitive loss to create more flood-safe housing, which lessens the financial and emotional burden of recurrent flooding on personnel and their families.

Nonconforming Structures

Structures become nonconforming when the zoning code or building regulations that were in place at the time of construction change, and the constructed building no longer meets the current requirements. The *Virginia Uniform Statewide Building Code* (USBC) and both Norfolk's and Virginia Beach's floodplain management ordinances meet NFIP minimum requirements, allowing certain repairs valued at up to 50 percent of a building's pre-improvement value to be permitted, without requiring that the structure meet current flood protection requirements for buildings located in the regulatory floodplain. If repairs, additions, or other improvements tally at least 50 percent of the pre-improvement value, the structure must be brought into full compliance with existing requirements.

The 50 percent threshold results in a situation in which a community may issue a succession of permits over time to the same nonconforming structure, which gradually increases the risk of the property from flooding. Subsequent floods can then cause more monetary damage to the structure.

Cumulative Substantial Improvement

A cumulative provision for tracking improvement and repair permits would promote long-term gain in the quantity and overall value of flood-safe housing. Within flood hazard zones, such a provision would ensure that the total value of all improvements or repairs permitted over a designated time period (such as 5 or 10 years) does not exceed 50 percent of the value of the structure. When the total cumulative value of proposed improvements meets or exceeds 50 percent, nonconforming structures would be required to institute protections according to the current floodplain management ordinance and USBC requirements for new buildings.

Norfolk and Virginia Beach could implement a cumulative substantial improvement provision by altering the definition of "substantial improvement" in their floodplain management ordinance.

Norfolk's definition of the term is provided in the *Zoning Ordinance*, Article 3 Zoning Districts, Subsection 3.9.7(G) Definitions, and could be modified as shown:

> **(36) Substantial Improvement**
> All *combinations of repairs*, reconstructions, rehabilitations, additions, or other improvements of a structure *taking place during [insert period of time selected by the community]* the *cumulative* cost of which equals or exceeds 50% of the market value of the structure before the "start of construction" of the improvement. *[Remainder unchanged]*

Virginia Beach's definition of the term is provided in Appendix K *Floodplain Ordinance*, Article IV Floodplain District Provisions, Subsection 1.3 Definitions, and could be modified as shown:

Substantial improvement. Any *combination of repairs*, reconstruction, rehabilitation, addition, or other improvement of a *structure taking place during [insert period of time selected by the community*], the *cumulative* cost of which equals or exceeds fifty (50) percent of the market value of the structure before the start of construction of the improvement. This term includes structures that have incurred substantial damage regardless of the actual repair work performed. [Remainder unchanged]

Repetitive Loss Provision

Federal flood insurance policies include coverage called Increased Cost of Compliance (ICC). Owners of NFIP-insured buildings that are located in special flood hazard areas (SFHA), and that are determined to meet the basic definition of "substantial damage" due to damage by flooding, are eligible to file ICC claims for up to $30,000 towards the cost of bringing buildings into compliance with the floodplain management requirements for new construction. In communities that adopt specific language addressing "repetitive loss" structures, such structures may be eligible for the ICC claim even if they do not meet the standard 50 percent threshold for substantial damage by a single event. To qualify, communities must adopt and enforce the repetitive loss provision on all buildings in SFHAs, not just those covered by federal flood insurance. The language that defines "repetitive loss" is specified in the National Flood Insurance Reform Act of 1994 (which modified 42 U.S.C. 4121. Definitions), the federal law that authorized the ICC coverage.[6]

The biggest beneficiaries of a repetitive loss provision are the flood-insured property owners who receive a claim supplemented by up to $30,000 to help with elevation, relocation, demolition, or floodproofing (only non-residential buildings can be floodproofed). Navy personnel benefits are two-fold: 1) the increased quantity of flood-safe housing in the long run provides more housing options that will not be affected when flooding occurs; and 2) in the event a flood occurs and a sailor's home is severely impacted, the availability of up to $30,000 ICC coverage helps the sailor (and their family) recover more quickly.

Norfolk has adopted a definition of "repetitive loss damage" in the *Zoning Ordinance*, at Article 3 Zoning Districts, Subsection 3.9.7(G) and then specifically regulates structures with "severe repetitive loss" at Subsection 3.9.7 (O)(1); however, the term "severe repetitive loss" is not defined. Norfolk could remove the word "severe" at Subsection 3.9.7 (O)(1) to implement this repetitive loss provision. While Virginia Beach separately defines "repetitive loss" in Appendix K *Floodplain Ordinance*, Article IV Floodplain District Provisions, Subsection 1.3 Definitions, the definition of "substantial damage" should be updated to include repetitive losses.

Compliance with all V Zone Standards in the Coastal A Zone

Post-flood evaluations, engineering calculations, and laboratory tests indicate that conventional construction sustains considerable damage when exposed to waves between 1.5 and 3 feet high. FEMA draws the inland boundary of the coastal high hazard area (V Zone) where modeling indicates waves will be less than 3 feet high during the 100-year flood. FEMA has delineated the inland extent of the 1.5-foot wave on both Norfolk and Virginia Beach Flood Insurance Rate Maps, and the areas between this line and the V Zone boundary are called "Coastal A Zones". NFIP minimum requirements do not address the Coastal A Zone.

The *Virginia Beach Floodplain Ordinance* does not have any requirements for the Coastal A Zone and the term is not defined. The Virginia USBC regulates Coastal A Zones, but not to the same stringent

6 See FEMA 301, *Increased Cost of Compliance Coverage: Guidance for State and Local Officials*, September 2003.

requirements as Norfolk's *Zoning Ordinance*. Norfolk regulations could be used to set a higher regional standard for the design of new and substantially improved structures in the Coastal A Zone that exceeds both the NFIP and USBC requirements. By setting a higher standard for structure design in Coastal A Zones, structures vulnerable to wave action would be more resilient, especially as the V Zone boundary migrates inland with rising seas.

Changes to Virginia Beach's floodplain management ordinance would be necessary to incorporate the following Norfolk higher standards for application in a newly defined "Coastal A Zone:"[7]

- Apply all V Zone standards to new or substantially improved structures in Coastal A Zone, to include engineered foundation with piles or columns (no stem walls), and lowest floor reference level set at bottom of the lowest horizontal structural member.
- Areas below the lowest floor must be free of obstruction, cannot have breakaway walls, cannot be partitioned into multiple rooms, be temperature-controlled, or be used for human habitation.
- Manufactured homes and recreational vehicles in the Coastal A Zone must meet the same standards as conventional construction.

Declaration of Land Restriction in Deeds

The NFIP regulations and USBC allow areas under elevated buildings to be wet floodproofed, and enclosed with specially-designed walls that equalize hydrostatic pressure on both sides of the wall, or are designed to breakaway in Coastal High Hazard Areas (V Zones). Virginia Beach has standards that match the NFIP and USBC requirements, while Norfolk does not allow walls at all in Coastal A Zones and Coastal High Hazard Areas (V Zones). In all flood zones, any enclosed area must be limited to use for parking of vehicles, storage, and building access.

The NFIP regulations do not require any form of owner agreement regarding modification or conversion of enclosures. Some communities elect to require nonconversion agreements or declaration of land restriction, recorded on the deed, for all enclosures. The objective is to reduce the likelihood that owners, including future owners, might convert enclosures to uses other than permitted uses, thereby increasing flood risk to the entire structure.

A recorded declaration of land restriction would have two advantages for Navy personnel: 1) the deed would disclose basic flood risk location information; and 2) the deed restriction would highlight the prohibition on conversion to habitable space for areas beneath elevated structures. Converting such space, even unknowingly, is a violation of local floodplain management ordinances.

7 Excerpts from Norfolk Zoning Ordinance, Subsection 3.9.7(K) are shown in the Appendix.

Local Policies and Design Standards

Both Norfolk and Virginia Beach have made significant efforts in recent years to consider the threat of flooding/sea level rise in their policy and planning.

- Norfolk's *Vision 2100* plan, adopted in 2016, is a long-range land use policy plan aimed at directing development away from areas threatened by sea level rise impacts, while designating areas for additional density and growth on the city's higher ground. Norfolk also adopted a new *Zoning Ordinance* in 2018 that offers incentives for development in areas less prone to flooding and sea level rise impacts, and seeks to deter development in areas of high flood risk. Norfolk also requires three feet of freeboard above the base flood elevation for new development and substantial improvements equivalent to 50% or more of the building's pre-improvement value.
- Virginia Beach is currently updating its *Master Drainage Plan*, and is mapping all of its existing drainage basins in order to better understand citywide drainage patterns. Virginia Beach is also wrapping up a *Comprehensive Sea Level Rise and Recurrent Flooding Study*. An update was released in January 2019 detailing the citywide flood protection strategies being explored by the study. Virginia Beach should incorporate findings from both studies as part of future Comprehensive Plan and Zoning Ordinance updates to ensure future land use policies and regulations are aligned. Virginia Beach has also adopted two feet of freeboard as a requirement for new development and substantial improvements in designated flood hazard areas.

Future updates to city Comprehensive Plan documents or sub area planning should also consider how sea level rise and flooding could impact access to the community assets and services all residents depend upon, such as hospitals, schools, police, fire, emergency management, water, and wastewater treatment plants. The community access analysis described in Chapter 2 identifies neighborhoods that could experience access impacts due to flooding, or where access will be impacted in the future with additional sea level rise. A closer examination is warranted to determine what services might be affected and to develop adaptation or mitigation strategies.

In October 2018, the HRPDC adopted a resolution[8] that encourages localities in Hampton Roads to consider adopting policies to incorporate sea level rise into their planning and engineering decisions. The resolution recommends that the adopted policies include planning for 1.5 feet of relative sea level rise above current mean higher high water (MHHW) for near-term (2018-2050) planning, 3 feet of relative sea level rise above current MHHW for mid-term (2050-2080) planning and 4.5 feet of relative sea level rise above current MHHW for long-term (2080-2100) planning.

These recommended guidelines are a positive step towards consistent planning-level guidance for incorporating sea level rise into municipal planning and engineering, and are consistent with the sea level rise scenarios used in the JLUS. The resolution recommends municipalities adopt policies that include selecting an appropriate sea level rise curve and design based on the requirements and needs, including risk tolerance and cost, of a specific project

8 Hampton Roads Planning District Commission 2018-01. *Resolution of the Hampton Roads Planning District Commission Encouraging Local Governments in Hampton Roads to Consider Adopting Policies to Incorporate Sea Level Rise into Planning and Engineering Decisions*. October 18, 2018. https://www.hrpdcva.gov/uploads/docs/HRPDC%20Resolution_Sea%20Level%20Rise%202018-01.pdf.

or policy decision. The Board's discussion included the advantages of a regional policy approach, in that it: 1) provides support for localities, 2) makes regional coordination simpler, 3) demonstrates to the public that the region is working together on the issue of sea level rise, and 4) creates a default position for state and federal entities on policies and projects.[9] Both Norfolk and Virginia Beach should adopt the regional policy on sea level rise or a similar policy.

Capital Improvement Planning

A regionally unified or consistent approach to sea level rise in project planning and design would be especially useful for stormwater, flood, utility, and roadway infrastructure that are shared or connected assets. It should also be a priority consideration for all capital improvement planning, especially critical infrastructure improvements. The City and County of San Francisco (CCSF) adopted Guidance on how city and county agencies must consider sea level rise for new capital improvement projects, including transportation improvements. The guidance provides direction from the Capital Planning Committee (CPC) to all departments on how to incorporate sea level rise into new construction, capital improvement, and maintenance projects.[10] The guidance describes steps for city and county departments to assess and adapt to the effects of sea level rise in capital projects.[11] A similar approach could be pursued for the Hampton Roads region.

4.4 TECHNOLOGY AND DATA

Smart data can drive decision-making and help communicate potential impacts and risks associated with flooding and sea level rise. Several initiatives are underway using innovative technology to collect data in support of resiliency planning, and to inform residents and employees about potential flooding. However, more could be done to coordinate these efforts across localities and with the Navy to expand their reach and efficacy. **Table 4-4** identifies technology and data strategies.

The Hampton Roads Geospatial Exchange Online (HRGEO) is an open source GIS data portal maintained by the HRPDC, with support from HRTPO and HRSD. The portal includes data published by the HRPDC/HRTPO, data from local, state, private, and federal sources that has been curated into regional datasets, and data gathered from localities. The portal is intended to help build a consistent approach to data use related to resiliency issues. HRGEO should be used for maintaining regional GIS and modeling data and sea level rise projections and data collected from sensor networks.

Additional steps also should be taken to define GIS-sharing protocols and permissions among the Navy and the cities to support infrastructure planning and design efforts. For example, the sharing of stormwater management system infrastructure data by the Navy could allow the city to complete more comprehensive modeling and technical analysis. Data sharing does exist at a project level, but standardized protocols would reduce delays.

9 Ibid.
10 City and County of San Francisco Sea Level Rise Committee. "Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability and Risk to Support Adaptation" Presentation, San Francisco, CA, September 22, 2014. https://www.sfmta.com/sites/default/files/agendaitems/2014/11-4-15%20Item%2011%20Report%20on%20Sea%20Rise%20level%20planning.pdf.
11 Ibid.

TABLE 4-4: TECHNOLOGY AND DATA

TECHNOLOGY AND DATA STRATEGIES	LEAD RESPONSIBLE PARTY
Support use of the HRGEO (http://www.hrgeo.org/) as regional portal to share modeling data and projections, sensor networks and data, GIS data, streamline access to technical studies, share scripts and codes, and test aps for improving information dissemination.	Cities
Define GIS data sharing protocols, requirements, and points of contact at cities and Navy to support cross-jurisdictional technical studies, analyses, and project execution.	HRPDC
Make Storm Sense operational as a forecasting tool and pursue long term funding for maintenance and operation.	HRPDC
Adopt a regional-serving alert system that incorporates flood warning information and explore new technologies to pilot warning systems. Ensure system includes and works with DoD and Virginia Port Authority Port systems.	Cities

City officials throughout Hampton Roads, including officials from Norfolk and Virginia Beach, have been working with the Virginia Institute of Marine Science to deploy new smart city technology in the form of flood sensors throughout the region as part of the Storm Sense Project[12]. These sensors monitor water levels throughout the region.[13] Making Storm Sense an operational forecasting tool and expanding the Storm Sense program to the DoD, Norfolk International Terminals, and private utilities would allow this program to directly benefit those organizations and their employees.

Norfolk is also collecting data using Waze and a program called "Connected Citizens" that aims to help state and local governments that use data submitted to Waze to improve transportation and emergency response.[14] Waze users can log obstacles like flooded roadways and alert other users of hazards. Integrating the flood sensor information to an application like Waze or other regional alert system like VDOT's 511 traffic alert system could allow Norfolk and Virginia Beach to warn drivers of flooded roads. Regardless of the application or platform used, the regional alert system should be compatible with the DoD and Virginia Port Authority to allow alerts to be issued at their facilities. Until a regional alert system is fully in place, the Navy should consider using electronic signage on base to warn drivers about roadway flooding (and congestion).

4.5 SUMMARY OF REGIONAL COORDINATION STRATEGIES

Table 4-5 lists the priority strategies described earlier in this section. Other regional coordination strategies that were not identified as high priority are listed in the Appendix. Additional supporting details for some strategies are also included in the Appendix.

12 The StormSense Project uses new state-of-the-art high resolution hydrodynamic models to forecast flooding from storm surge, rain, and tides at the street-level scale: https://www.us-ignite.org/apps/m6iagJEeuyERYnBkA2XGxf/.
13 "StormSense." Vims.edu. Accessed May 6, 2019. https://www.vims.edu/people/loftis_jd/StormSense/index.php.
14 Murphy, Ryan. "Waze Helps Track Flooding, and Could Predict the Future." , *The Virginian Pilot*, August 5, 2018. https://www.usnews.com/news/best-states/virginia/articles/2018-08-05/waze-helps-track-flooding-and-could-predict-the-future.

TABLE 4-5: SUMMARY LIST OF REGIONAL COORDINATION STRATEGIES

#	STRATEGY	LEAD RESPONSIBLE PARTY
Coordination and Outreach Strategies		
1	Adopt a Memorandum of Understanding among JLUS partners to commit to working together to advance and implement JLUS priorities and establish a JLUS Implementation Committee as an outcome of the MOU.	HRPDC
2	Coordinate on Navy access control point (gates) projects and establish Navy policy to consider transit as part of new and redesigned gate access projects.	U.S. Navy
3	Develop a stormwater systems maintenance MOU for each installation and respective locality to define ongoing roles and responsibilities for routine maintenance of ditches, culverts, and other drainage components that span locality/Navy jurisdiction.	HRPDC
4	Encourage utility providers to provide regular updates on infrastructure upgrades. Define clear communication protocols and points of contact between local utilities, private providers (Dominion, VA Natural Gas), and the Navy to improve coordination on projects and expedite action during emergency events.	HRPDC
5	Establish coordination protocols between city floodplain managers and Navy support personnel to share information about flood risk, flood insurance, existing city programs, floodplain development regulations.	Cities
6	Develop outreach materials for DoD personnel about the flood risks in the area; incorporate into Navy briefings to families; disseminate through Fleet and Family Services (target military spouses).	U.S. Navy
7	Update the *Military Commuter Survey* (HRTPO) to address issues related to flooding and sea level rise and how these issues affect overall access to work and other services.	HRTPO
Advocacy Strategies		
8	Encourage Congress to appropriate funding for the Defense Community Infrastructure Program (DCIP).	JLUS Partners
9	Encourage the DoD to require that proposed projects be identified in a JLUS to be eligible for DCIP funding and to use criteria consistent with this study's methodology to evaluate candidate projects.	HRPDC
10	Pursue an amendment to the VDOT Smart Scale criteria to include sea level rise, flooding, and military readiness as factors for prioritizing projects for funding.	HRTPO
11	Pursue an amendment to the Code of Virginia and the Virginia Residential Property Disclosure Act for mandatory disclosure requirements for flood hazard for real estate transactions (purchase and rental).	HRPDC
Policy/Development Regulation Strategies		
12	Adopt the recommended regional policy for incorporating sea level rise into planning and engineering decisions, or similar policy.	Cities
13	Implement a cumulative substantial improvement provision for tracking improvements to structures in the flood hazard area over a pre-determined period, such as 5 or 10 years.	Cities
14	Strengthen repetitive loss definitions in local floodplain management ordinances to provide added protections to insured property owners.	Cities
15	Require a recorded declaration of land restriction to disclose flood risk location information and to highlight the prohibition of converting areas under elevated structures to habitable space.	Cities

TABLE 4-5: SUMMARY OF LIST OF COORDINATION STRATEGIES (continued)

#	STRATEGY	LEAD RESPONSIBLE PARTY
16	Develop regional guidance for incorporating flooding and SLR into city capital planning projects to ensure that all projects adequately address flooding and sea level rise vulnerability, risk, and adaptation.	HRPDC
17	Request that state agencies incorporate Hampton Roads regional guidance, or similar policy, for flooding and SLR into all state-level capital planning projects and studies.	HRPDC
18	Continue to update and revise Comprehensive Plans, Zoning Ordinances, and variance requirements to align land use, density, height restrictions, open space requirements, setbacks, and other building restrictions to limit density of future development or post-disaster redevelopment in areas where flood risk is highest now and in the future.	Cities
19	Consider risks associated with flooding and SLR as part of any Comprehensive or area plan update and evaluate options to address those neighborhoods where access to community assets could be affected by flooding and SLR.	Cities
Technology and Data Strategies		
20	Support use of the HRGEO (http://www.hrgeo.org/) as regional portal to share modeling data and projections, sensor networks and data, GIS data, streamline access to technical studies, share scripts and codes, and test apps for improving information dissemination.	Cities, HRPDC
21	Define GIS data sharing protocols, requirements, and points of contact at cities and Navy to support cross-jurisdictional technical studies, analyses, and project execution.	HRPDC
22	Make Storm Sense operational as a forecasting tool and pursue long term funding for maintenance and operation.	HRPDC
23	Adopt a regional-serving alert system that incorporates flood warning information and explore new technologies to pilot warning systems. Ensure system includes and works with DoD and Virginia Port Authority systems.	Cities

5 MODEL PROJECTS

As part of the JLUS process, two Actions were identified for further study and development of potential design concepts and ROM costs: Hampton Boulevard in Norfolk, and the East Amphibious Drive, Chubb Lake, and Lake Bradford area surrounding the eastern side of JEB Little Creek in Virginia Beach.

There is significant benefit in pursuing some level of concept design to test ideas and in illustrating how a concept could work, including the potential costs and steps necessary to advance it forward. A concept design, through illustrations and graphics, can more effectively articulate potential benefits and opportunities that could not otherwise be understood. It can also help build understanding about the necessary next steps and the potential level of funding required.

The Actions were chosen for the following reasons:

- The design challenges differ in scale and complexity and could therefore serve as a model for developing solutions and lessons learned that apply more broadly.
- Observed flooding has been identified, which has a direct impact on military readiness. Increased storm events and sea level rise will exacerbate flood impacts over time.
- These areas have stormwater management infrastructure that crosses jurisdictional boundaries, is under varying maintenance regimens, and is unable to manage runoff sufficiently.
- Any solution will require coordination between the Navy, Norfolk, Virginia Beach, and other major stakeholders to ensure a successful outcome.

Table 5-1 shows the JLUS Actions and the ranking each action received based on the evaluation criteria discussed in Chapter 3.

The purpose of this Chapter is to describe the results of the model project effort, ROM costs,[1] and implementation factors that should be considered to advance these concepts forward. The ideas presented here propose one way of addressing the identified challenges. However, other solutions may exist, and more detailed infrastructure engineering, design, and cost estimating would be required to confirm that a concept is viable.

TABLE 5-1: JLUS ACTIONS STUDIED AS MODEL PROJECTS

SPECIFIC JLUS ACTIONS	ACTION SCORE
Action #1: Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy	19/25
Action #4: East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy	17/25

1 Detailed ROM costs are included in the Appendix.

5.1 HAMPTON BOULEVARD

The Hampton Boulevard corridor is a primary corridor serving the military that directly connects to entry control points at NS Norfolk and NSA Hampton Roads. This highly urbanized corridor provides direct access from downtown Norfolk and the Midtown Tunnel Area to critical DoD assets, and is a primary route connecting NS Norfolk to Special Area Craney Island Fuel Depot to the west, and LRA to the south. In addition to providing direct access to both installations, Hampton Boulevard provides important employee and contractor access to the Virginia Port Authority's NIT, which is part of the Port of Virginia. This model project presents an opportunity to explore how Norfolk, the Navy, and the Virginia Port Authority can partner to manage water and mitigate flood risk, and achieve a mutually beneficial outcome that helps retain access to the Navy's and the Port Authority's strategic assets.

Hampton Boulevard is discussed in two phases, north and south, because of the variation in existing underlying infrastructure conditions, anticipated future flood conditions, and potential implementation factors that could influence how the project is scoped and funded.

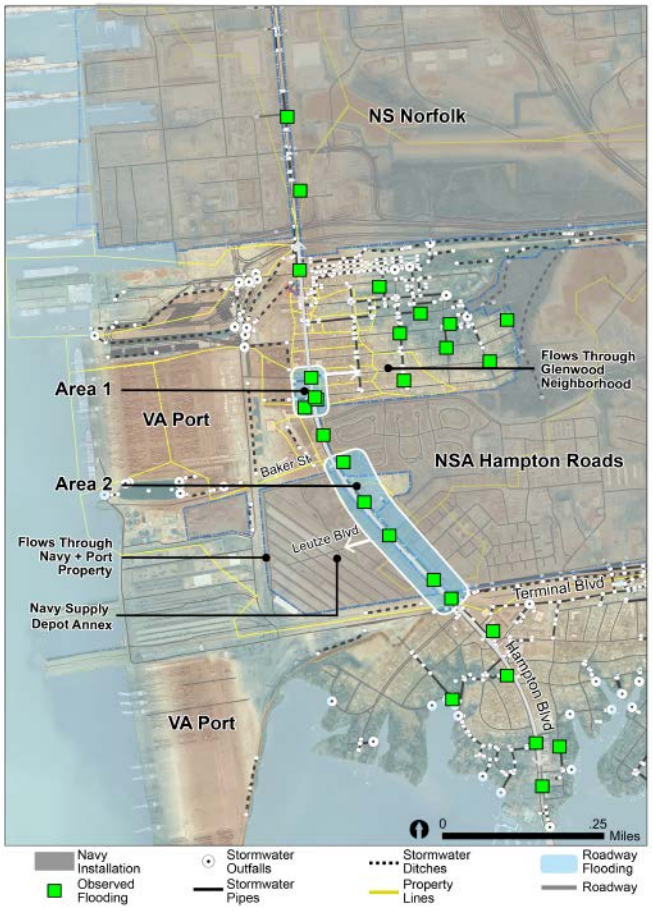

FIGURE 5-1: Hampton Boulevard North – Existing Conditions Diagram and Drainage Patterns

5.1.1 NORTHERN PHASE

The northern phase is defined as the area between Terminal Boulevard and I-564 near NS Norfolk. Flooding along this segment is primarily due to storm surge events or heavy rainfall, and data show a history of recorded flood observations in the area (see **Figure 5-1**). The existing stormwater infrastructure along this segment is owned and maintained by Norfolk, the Navy, and the Virginia Port Authority. Drainage patterns differ along the segment, and stormwater from the corridor flows both east and west. Drainage in the northern area collects in pipes along Hampton Boulevard and is directed through the Glenwood Park subdivision before discharging through a series of wetlands and ditches within NS Norfolk.

This neighborhood is prone to both stormwater and tidal flooding. South of Glendale Avenue, a high point along Hampton Boulevard causes runoff to flow southward, where it is collected by streetside inlets and conveyed northward toward Leutze Boulevard, along with drainage from Terminal Boulevard. Norfolk's pipe infrastructure ends at the junction of several pipes at Leutze Boulevard. Based on available GIS information, stormwater leaves Norfolk's system at that junction and drains west to the Elizabeth River through a combination of Navy and Virgina Port

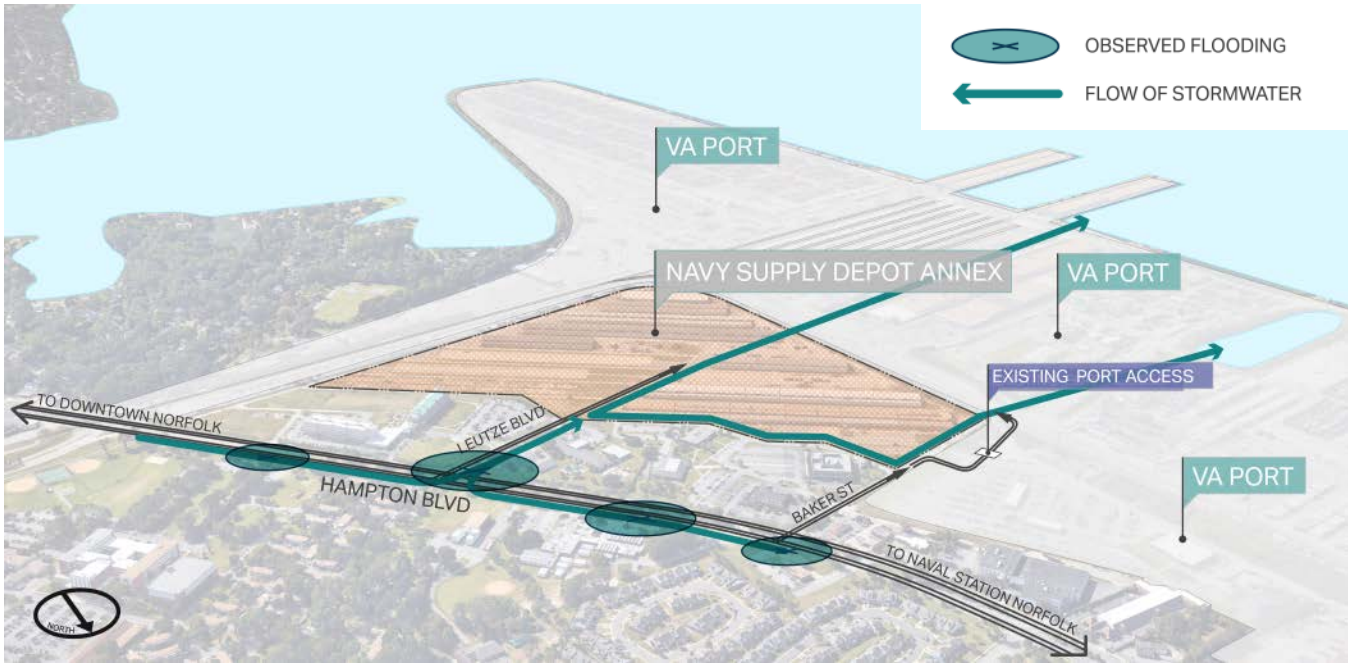

FIGURE 5-2: Hampton Boulevard North – Existing Drainage Pattern Near Baker Street

Authority pipe systems running under the Navy Supply Depot Annex and NIT properties, as shown in **Figure 5-2**. The outfall from this system does not have a tidal backflow prevention device. The condition of this system connecting the Leutze Boulevard junction to the outfall should be evaluated as part of the surveying and other field investigations that would be completed when implementing this action.

During intense rainfall events, when runoff along the corridor is unable to get into the drainage system fast enough and/or the system is unable to handle the volume of flow, water backs up at the inlets and onto the roadway. This effect can be worse when tides are high at the outfalls, a condition that will worsen as sea levels rise. This "spread" restricts access along the corridor. Portions of the southbound lanes are frequently impassable during storm events–a common issue at the intersection of Hampton Boulevard and Baker Street. These issues are compounded during peak gate access times at NS Norfolk and NIT. Norfolk staff have noted that recent maintenance and cleaning of pipes has resulted in less frequent flooding of the southbound lanes.

5.1.2 NORTHERN PHASE PROPOSED SOLUTIONS + BENEFITS

A series of interventions in three areas that would work together to improve the performance of the stormwater management infrastructure and reduce impacts from flooding are proposed. In the area of Forest Avenue and Glendale Avenue, the recommendation is to disconnect Hampton Boulevard inlets from the Glenwood Park drainage system and instead route stormwater more directly west, toward the river. The specifics of routing flows westward would have to be developed in coordination with the Virginia Port Authority to avoid conflicts with existing NIT infrastructure and operations. This coordination also presents an opportunity to reduce pressure on NIT stormwater management infrastructure by reducing the amount of flow directed

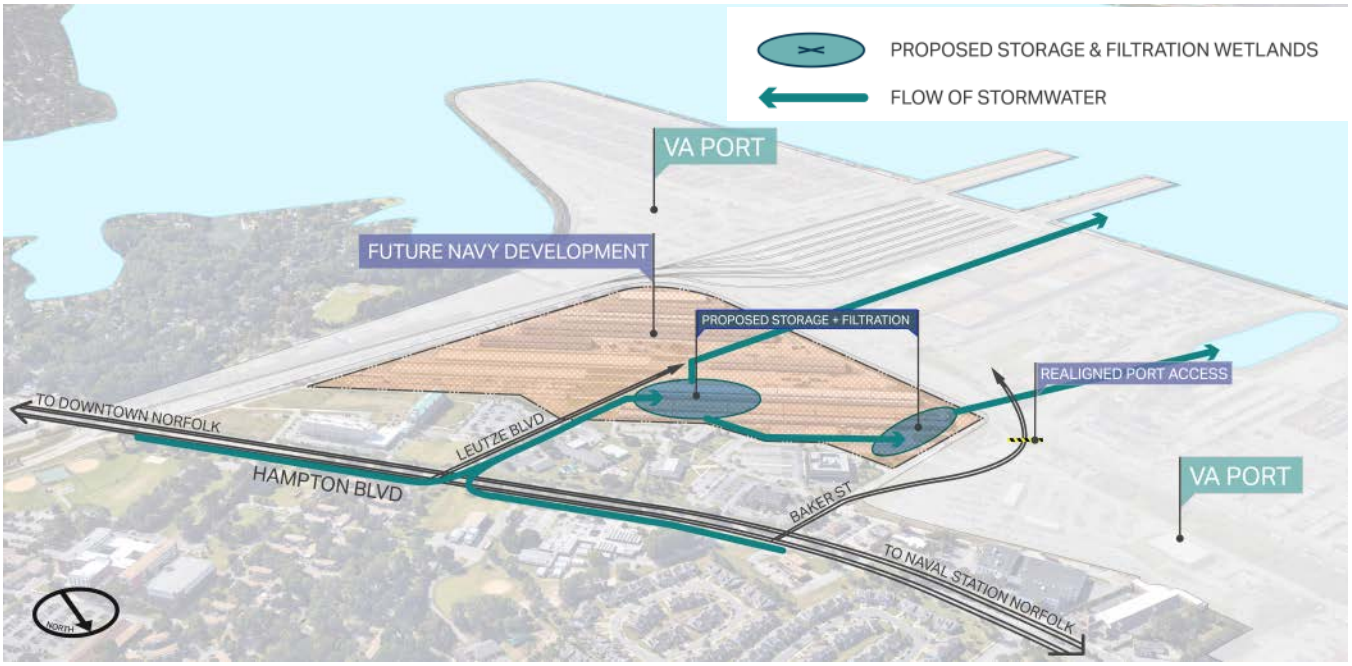

FIGURE 5-3: Hampton Boulevard North – Conceptual Solution

through the Glenwood Park neighborhood. This concept should therefore be considered as part of any comprehensive stormwater strategy for that neighborhood and NIT.

The solutions proposed in the area of Baker Street and Leutze Boulevard would continue Norfolk's efforts to clean out and improve drain inlet infrastructure along Hampton Boulevard. Stormwater would then be conveyed westward along the Baker Street and Leutze Boulevard rights-of-way to newly created storage and filtration wetlands, as shown in **Figure 5-3**. These features would then overflow to discharge either through existing NIT drainage system outfalls or through new outfalls on new storm pipes running under the NIT site. This additional storage and filtration would be located on property owned by the Navy, known as the Supply Depot Annex, as shown in **Figure 5-4**. Conversations with the Navy indicate that the Supply Depot Annex could be redeveloped in the future, and this conceptual solution could help inform the master plan for the site, including the stormwater management requirements.

The concept also creates an opportunity to realign Baker Street and, in the process, intercept runoff before it enters the Hampton Boulevard-right-of-way. NIT could benefit from this realignment, because it could ease access for port workers and improve access to the NIT gate. This concept could be designed to achieve broader water quality goals for the Navy, the Virginia Port Authority, and Norfolk.

The concept solution for the northern segment offers benefits to the Navy, the Virginia Port Authority's NIT site, and Norfolk, as shown in **Table 5-2**.

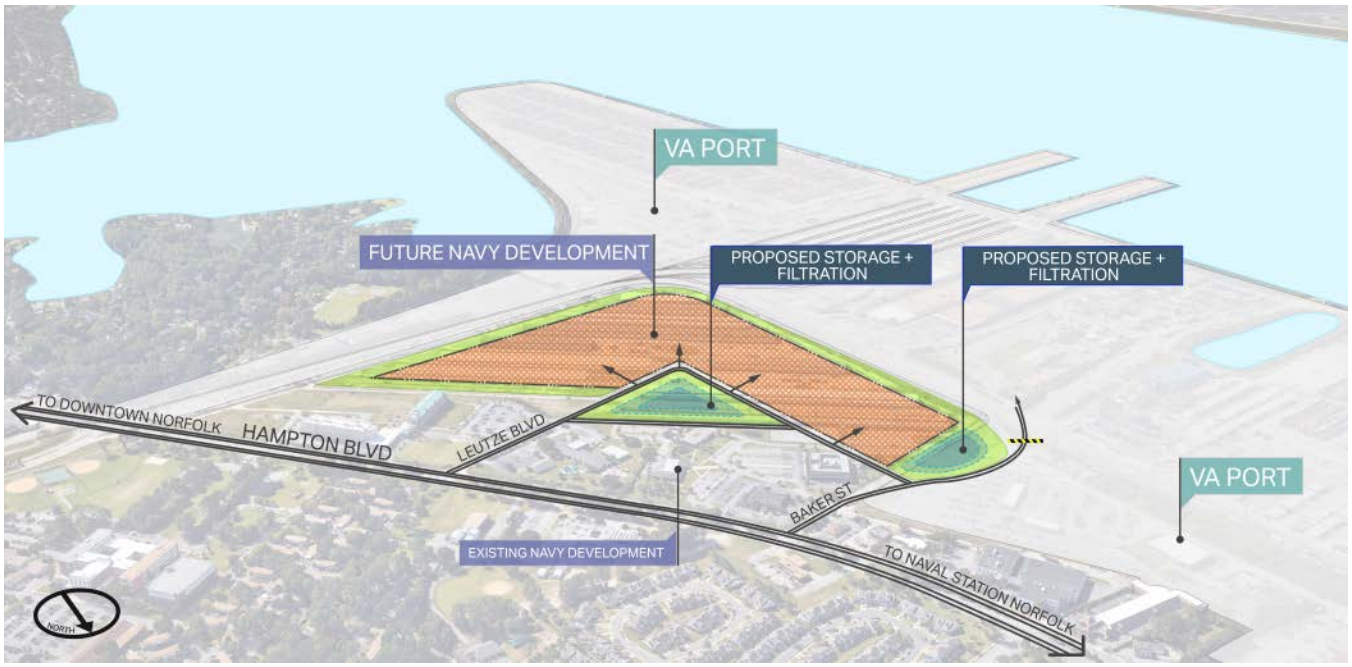

FIGURE 5-4: Hampton Boulevard North – Conceptual Solution Integrated with Redevelopment

TABLE 5-2: NORTHERN SEGMENT CONCEPT SOLUTION BENEFITS

BENEFIT	BENEFICIARY		
	NAVY	PORT	NORFOLK
Reduces current and future flood risk for military personnel along a primary DoD strategic corridor.	X		
Reduces delays for military personnel entering and exiting the installations and housing areas.	X		
Provides a stormwater management solution for future Navy development.	X		
Maintains access to businesses, public schools, and neighborhoods along Hampton Boulevard.	X	X	X
Mitigates the effects of tidal backups and overwhelmed inlet capacity to reduce the frequency and duration of flooding on Hampton Boulevard.	X	X	X
Stores runoff outside of the Hampton Boulevard right-of-way.	X	X	X
Improves access alignment for NIT employees and deliveries.		X	
Reduces flood blockage along Baker Street and improves safety.	X	X	X

5.1.3 NORTHERN PHASE IMPLEMENTATION CONSIDERATIONS

Achieving an effective solution for stormwater management along this segment of Hampton Boulevard requires a cooperative strategy between the Navy, the Virginia Port Authority, and Norfolk. Additional implementation considerations include:

- Developing an MOU to define a process for working together on this specific issue. The MOU could include specific objectives, such as those noted below, as well as a proposed timeline for action and how activities will be coordinated with any ongoing projects.
- Implementing a joint project planning and engineering team with representatives from Norfolk, the Virginia Port Authority, and the Navy.
- Utilizing a detailed stormwater H&H model that integrates Norfolk, Navy, and Virginia Port Authority/NIT drainage systems connected to the northern Hampton Boulevard corridor to evaluate conceptual designs. All three entities should, at a minimum, share data to support this integrated approach, so that solutions can be properly designed.
- Incorporating future precipitation and sea level conditions into the design of any new stormwater pipes.
- Addressing Navy and NIT facility needs, stormwater management goals, and access requirements as part of the master plan development process for the site.
- Identifying roles and responsibilities for maintenance of future stormwater management infrastructure as part of a long-term maintenance agreement. This is a critical need, as the effectiveness of the system will span multiple entities, and regular maintenance and upkeep will be required. The agreement would need to address access and security concerns of the Navy and Virginia Port Authority/NIT.
- Identifying specific state and federal funding opportunities. For example, Hampton Boulevard may qualify for funding under the Defense Access Roads program, and the new DCIP, as authorized under the FY19 National Defense Authorization Act (once funding is appropriated).

A high-level ROM estimate for the Hampton Boulevard northern phase is outlined in **Table 5-3**. Additional detail and a list of assumptions is provided in the Appendix.

TABLE 5-3: HAMPTON BOULEVARD NORTH SEGMENT – ROM SUMMARY

HAMPTON BOULEVARD NORTH SEGMENT	ROM COST OF ENHANCEMENTS*	ROM ASSUMPTIONS
Vicinity of Glendale and Forest Avenue	$757,000	1,500 linear feet of 60" reinforced concrete pipe
Vicinity of Baker Street and Leutze Boulevard	$6,436,000	5,500 linear feet of 48" reinforced concrete pipe, bioretention areas, and 2 tide gates

*CONTINGENCY (35%) AND DESIGN/PERMITTING (12%) FEES INCLUDED

5.1.4 SOUTHERN PHASE

The southern phase is defined as the segment of Hampton Boulevard between the south side of the Lafayette River Bridge and the intersection of Rockbridge Avenue. Tidal flooding, exacerbated by sea level rise, will dramatically impact access along this portion of the corridor, including to and from the neighborhoods adjacent to the corridor, and to the Navy's LRA (see **Figure 5-5**).

A high-level analysis of the existing road grades based on HRPDC's LiDAR DEM confirms that this segment of the corridor and its adjacent neighborhoods and streets are currently vulnerable to minor tidal flooding events. Without intervention, this segment is likely to experience more frequent flooding during minor tidal flooding events as sea level rise progresses. The current roadway elevation in this segment ranges between a low of 2.5 feet NAVD88 near Lexan Avenue to a high of over 6.0 feet NAVD88 just south of Rockbridge Avenue. This variation in elevation means that not all areas of the corridor will experience the same frequency and depths of flooding impacts in a given event. However, in the 1.5-foot sea level rise scenario, flooding depths in the lower spots on the corridor and at key intersections will effectively block access from the south to both the LRA and the bridge across the Lafayette River during minor tidal flooding events.

To better understand the potential impacts from long-term sea level rise and to inform future design solutions for the corridor, a comparison between daily high-tide impacts and minor tidal flooding impacts with SLR was undertaken. This helps to illustrate what segments of the corridor would potentially become impassable on a more frequent basis and which areas within the adjacent neighborhood areas would experience frequent flooding impacts. This analysis was done to gain a better understanding of what level of mitigation should be further explored for the corridor to achieve a long-term solution for maintaining access as sea levels rise.

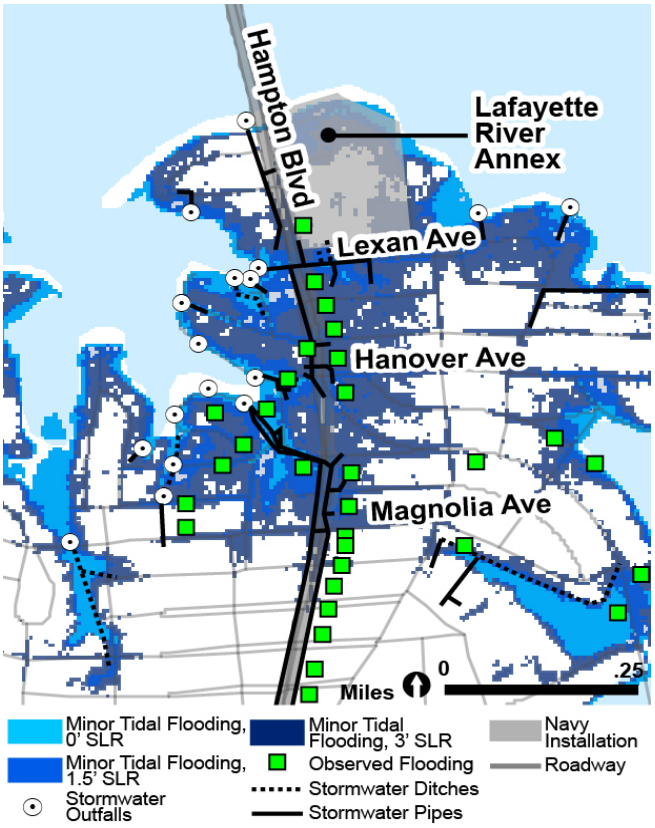

FIGURE 5-5: Hampton Boulevard South – Conditions Under Future Sea Level Rise Scenarios

FIGURE 5-6: Areas Along Hampton Boulevard Impacted During Daily High Tide and 1.5 Feet of SLR

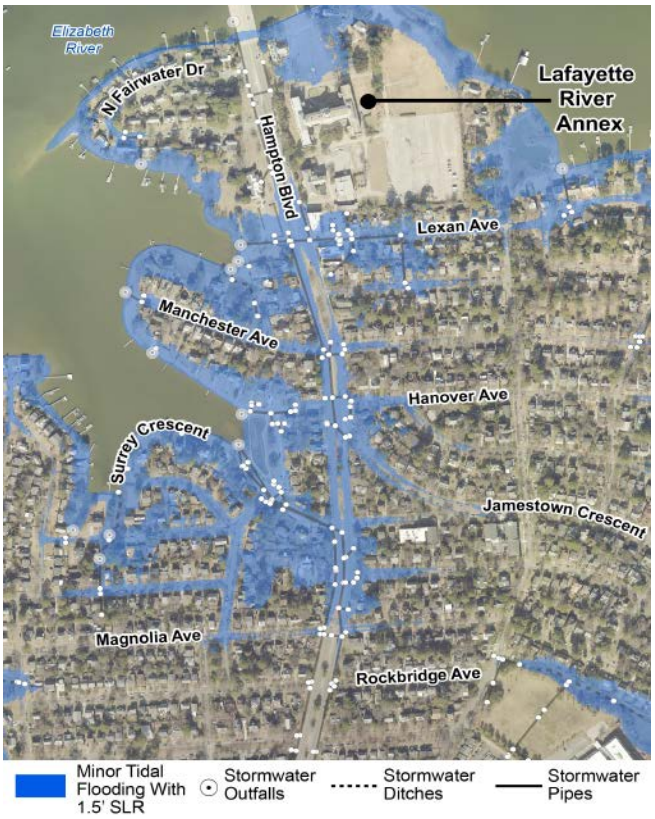

FIGURE 5-7: Areas Along Hampton Boulevard Impacted During Minor Tidal Flooding and 1.5 Feet of SLR

Figure 5-6 shows the areas that would be impacted at daily high tide under 1.5 feet of SLR. The areas in blue would experience flooding during some part of most days, around high tide, based on daily tidal cycles. In the absence of rainfall, impacts to Hampton Boulevard itself would be minimal, though portions of the neighborhoods and waterfront streets would be affected.

Figure 5-7 shows areas that would be impacted in a minor tidal flooding event and 1.5 feet of SLR. By definition, this condition occurs less frequently than daily high tides, but in the study area, minor tidal flooding events occur several times each year. With 1.5 feet of sea level rise, the adjacent area that would experience flooding in such an event increases significantly.

Approximately 2,000 feet of Hampton Boulevard would be impassable between Lexan Avenue and Magnolia Avenue. At least eight intersections would potentially be impacted, including Lexan Avenue, which provides access to the LRA.

Flooding of the Lexan Avenue intersection would also prevent drivers from routing around the flooded areas, because they would not be able to get on or off of Hampton Boulevard south of the bridge. The Hampton Boulevard intersections of Richmond Crescent, Jamestown Crescent, Larchmont Crescent, and Surrey Crescent are all notably lower than the adjacent Hampton Boulevard segments. In addition, many of the adjacent roadways and properties would experience impacts and reduced

FIGURE 5-8: Areas Impacted Along Hampton Boulevard During Daily High Tide and 3.0 Feet of SLR

FIGURE 5-9: Areas Impacted During Minor Tidal Flooding and 3.0 Feet of SLR

access. **Figure 5-6** and **Figure 5-7** depict conditions that could occur around the 2035 and 2040 timeframe.

Figure 5-8 shows the areas that would be impacted at daily high tide under 3.0 feet of SLR. The areas in blue would experience flooding during some part of the day based on daily tidal cycles. Impacts to Hampton Boulevard would be significant, and larger areas of the adjacent neighborhoods, particularly west of the boulevard, would be affected.

Figure 5-9 shows areas that would be potentially impacted under minor tidal flooding and 3.0 feet of SLR. As noted above, this type of impact from minor tidal flooding would occur in the study area several times each year. The area that would experience flooding increases significantly. Approximately 3,000 feet of the roadway would be impassable. In addition, adjacent properties and neighborhood access would be impacted.

In addition to the intersections blocked by minor tidal flooding with 1.5 feet of SLR noted above (all of which would experience greater flooding depths and durations in 3.0 feet of SLR), the Rockbridge Avenue intersection would become vulnerable to flooding with 3.0 feet of SLR.

This condition would drastically impact access along the entire corridor, which would experience greater depths and longer durations of flooding on a more frequent basis as sea level rise continues.

5.1.5 SOUTHERN PHASE PROPOSED SOLUTIONS + BENEFITS

Identifying a solution for this segment of Hampton Boulevard requires a more in-depth analysis and comparison of alternatives that explore different design solutions to address the long-term impacts of sea level rise. Time versus risk tolerance is an important consideration when pursuing major infrastructure upgrades. Flooding from tidal events and storms at the Lexan Avenue intersection already blocks ingress and egress to the Annex (and points south), and this current condition is already impacting military readiness.

Based on the analysis described above, an evaluation of alternatives is recommended and should include concepts for elevating the roadway. **Figure 5-10** shows the potential additional elevation that would be required along segments of the roadway to provide access along Hampton Boulevard during minor tidal flooding and 3.0 feet of SLR. The length of roadway that would need to be studied in an alternatives analysis is, at a minimum, 3,000 linear feet. However, this length should be determined by more detailed analysis as part of pre-scoping activities for the alternatives analysis.

5.1.6 SOUTHERN PHASE IMPLEMENTATION CONSIDERATIONS

Future impacts from flooding and sea level rise will mean that the conditions and the character along the corridor will change over time. As such, the design and function of the corridor will likely also need to change. An exploration of alternatives can provide a pathway for exploring the impacts and benefits of various design options, including elevating the road, along with a public debate about accepted levels of risk. Several issues will need to be addressed as part of any future alternatives study:

- Safety and operational considerations of the roadway need to be integrated into the analysis. Hampton Boulevard is currently a heavily traveled corridor. A travel demand analysis of the corridor should be done to understand the impacts on the network from future flooding and sea level rise. Any reductions or modifications to travel lanes that are defined as part of the alternatives analysis should be analyzed. Transportation safety rules would have to be considered in the design of modified driveway connections to Hampton Boulevard.
- Raising Hampton Boulevard to the minor tidal flooding threshold with 3.0 feet of sea level rise would require reworking all of the neighborhood streets that connect to the roadway. It is estimated that a minimum of 11 intersections would need to be redesigned, including two signalized intersections. If the study area were extended farther south, there would most likely be additional intersection impacts. Redesigning the intersection of multiple streets by 2 feet or more, in a short distance beween Hanover Avenue, Jamestown Crescent, and Surrey Crescent, would be particularly challenging.
- It is estimated that over 60 parcels are located along the 3,000-linear-foot segment, from the Lafayette River Bridge to Rockbridge Avenue. Extending this segment farther south would have an even greater impact on private properties, including some properties not directly adjacent to Hampton Boulevard. Changes to the roadway geometry would likely have an impact on access to adjacent parcels, including driveways (in addition to connecting streets). Obtaining enough right-of-way to accommodate raising the roadway to be passable with 3.0 additional feet of sea level rise may require property acquisition and/or impact the public realm, another added complication.

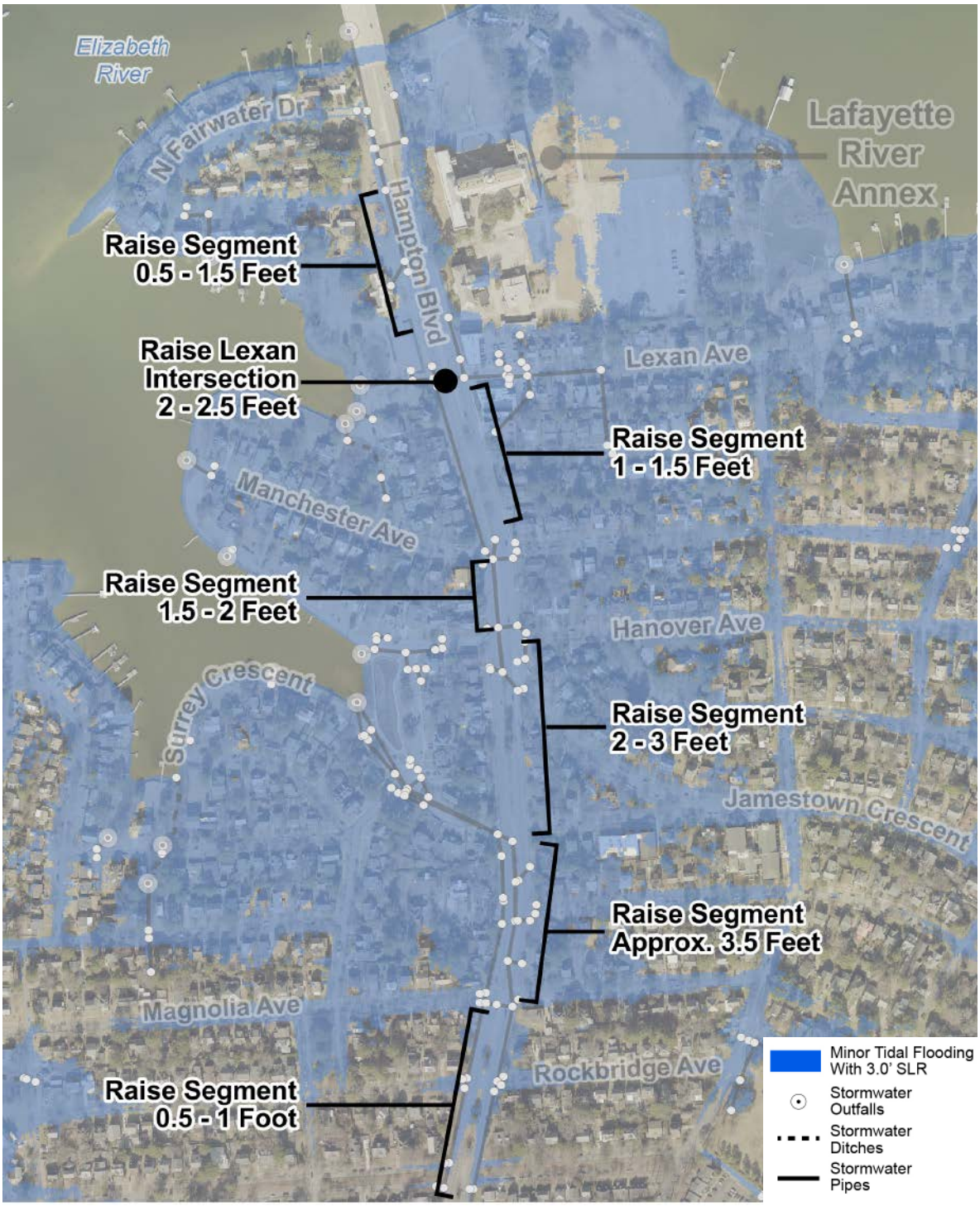

FIGURE 5-10: Hampton Boulevard Estimated Required Elevation During Minor Tidal Flooding and 3.0 Feet of SLR

- The stormwater collection system would have to be redesigned to collect runoff from adjacent properties that currently drain to the street and its stormwater inlets, as most of the existing drainage pathways would be cut off by raising the road. In turn, modification of the stormwater collection system would have to avoid, or account for, conflicts with other existing buried utilities such as water, sanitary sewer, and gas lines in the right-of-way. Other utility infrastructure, such as water and sewer manholes, telecommunications infrastructure, or electric lines, may also be affected.

These proposed solutions would keep the Hampton Boulevard corridor accessible in the tidal flooding scenarios evaluated. Segments of Hampton Boulevard south of Rockbridge Avenue have been observed to flood in the past, and this has been primarily due to intense rainfall events. While the specific proposed infrastructure solutions do not address rainfall flooding in the larger area, these issues should be evaluated in the recommended H&H study.

The issues described identify some, but likely not all, of the challenges that would need to be addressed as part of an alternatives study. The challenges along this segment of the corridor are complex and would require significant engagement with the affected public, Norfolk Utilities, transportation, and planning staff to develop a meaningful feasibility and cost analysis.

In addition to evaluating alternatives for a larger-scale intervention, such as the described roadway changes, tide gates should be added to critical outfall locations, as shown in **Figure 5-11**, to prevent tidal backflow through the pipes (i.e., a CheckMate® valve or similar). This added level of automatic control would help to mitigate current nuisance tidal flooding that will be

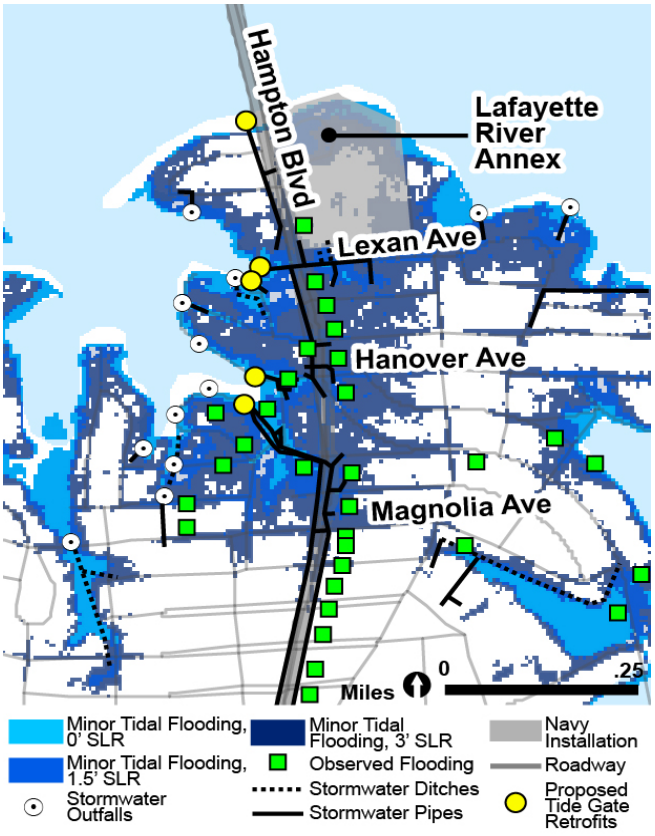

FIGURE 5-11: Hampton Boulevard South – Proposed Tide Gate Locations

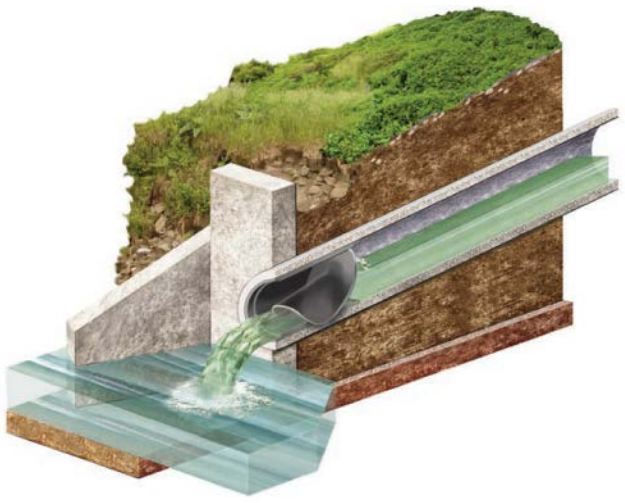

FIGURE 5-12: Example of CheckMate® in End of Pipe Application

exacerbated with sea level rise. An example of a CheckMate® valve type of backflow preventer application is shown in **Figure 5-12**.[2]

The estimated ROM cost for five tide gates is $675,000. Additional cost items that would need to be considered for any elevation concept along Hampton Boulevard are listed below. This list is not exhaustive; other cost factors may exist.

Example Roadway Design and Construction Costs

- Transportation congestion/travel demand modeling
- Review of environmental impacts
- Right-of-way acquisition
- Excavation/earthwork and demolition of existing curb and gutter, sidewalks, and roadway
- Fill and grading of raised roadway sub-grade
- Construction and marking of new pavement, curbs and gutters, and sidewalks
- Modification or rerouting of driveway and side street connections
- Upgraded roadway intersections and signalization
- Management of traffic during construction

Example Stormwater Management Costs

- Comprehensive stormwater collection, conveyance, and discharge H&H modeling of the redesigned roadway and adjacent areas
- Roadway drainage curb and drop inlets and stormwater conveyance pipe upgrades
- Bioretention and/or green infrastructure elements
- Erosion control
- Pump station(s)
- Tide valves or gates on stormwater outfalls

Example Utilities Costs

- Utility relocation, construction, undergrounding, or hardening

2 "The Checkmate® Advantage Engineering Guide." Redvalve.com. Accessed May 6, 2019. https://www.redvalve.com/uploads/Extranet_PDFs/Checkmate_Advantage_Brochure.pdf.

5.2 EAST AMPHIBIOUS DRIVE, CHUBB LAKE, AND LAKE BRADFORD FLOOD MITIGATION AND STORMWATER MANAGEMENT STRATEGY

The area surrounding JEB Little Creek is low-lying and relatively flat, with several freshwater and saltwater bodies surrounding it. These characteristics influence the drainage patterns surrounding the installation, including how water moves through the base itself.

The base currently experiences recurrent tidal and precipitation-related flooding that can create significant internal access challenges along Amphibious Drive, a critical east-west corridor for traffic within the base. When these issues occur, the base relies upon Shore Drive to reach other parts of the installation, placing increased importance on that section of the corridor outside the base's fenceline. Shore Drive also experiences flooding in precipitation events, and sections of Shore Drive are at risk of tidal flooding in the sea level rise scenarios evaluated. If both Amphibious Drive and segments of Shore Drive local to JEB Little Creek were to flood at the same time, vehicle access from one side of JEB Little Creek to the other would be cut off for the duration of the flooding event.

In addition to recommending a comprehensive flood mitigation and stormwater management strategy for Shore Drive, the JLUS defines an Action to further investigate the causes of recurrent flooding around JEB Little Creek, including along Shore Drive near the area of Gate 1 and Amphibious Drive near Lake Whitehurst. Virginia Beach's ongoing *Stormwater Master Plan Update* is currently modeling areas further east along Shore Drive, and the results of those efforts may be used to help guide the next steps.

A third area of concern for JEB Little Creek occurs around the Boone Clinic on base. Several contributing factors and conditions influence the flooding in this area, including the capacity of the interconnected stormwater management infrastructure, the condition of nearby wetlands, and the management of Lake Bradford and Chubb Lake. This model project is focused on this area and represents an opportunity to explore how the Navy and Virginia Beach can partner to manage and control water and to help prevent flood impacts on and off base.

5.2.1 CHALLENGES

Figure 5-13 shows the general drainage pattern and flow of water along the eastern and southern perimeter of JEB Little Creek. The entire Little Creek Harbor is subject to tidal flows from the Chesapeake Bay. Tidal flows and water levels can cause direct flooding along the Little Creek waterfront and Amphibious Drive by overtopping bulkheads and traveling upstream through drainage culverts, such as those under Helicopter Road. Tidal conditions also indirectly contribute to flooding, by hindering stormwater drainage from adjacent lakes, ditches, and the on-base storm drain system. The Boone Clinic parking and access streets are impacted by minor tidal flooding events in the present day. Both the area around the clinic, and longer stretches of Amphibious Drive, will be impacted more frequently by minor tidal flooding in the 1.5-foot and 3.0-foot SLR scenarios.

Rainfall events also contribute to flooding potential within this area. JEB Little Creek is at the receiving end of a large drainage area that includes a number of Virginia Beach neighborhoods outside the base. Most of the off-base drainage discharging to the eastern part of Little Creek Harbor comes from residential and commercial areas that drain first to Lake Bradford and Chubb Lake, then through an on-base drainage canal that runs past the Boone Clinic before discharging under Helicopter Road. Flows through the drainage canal can be controlled by an existing weir gate operated by the Navy.

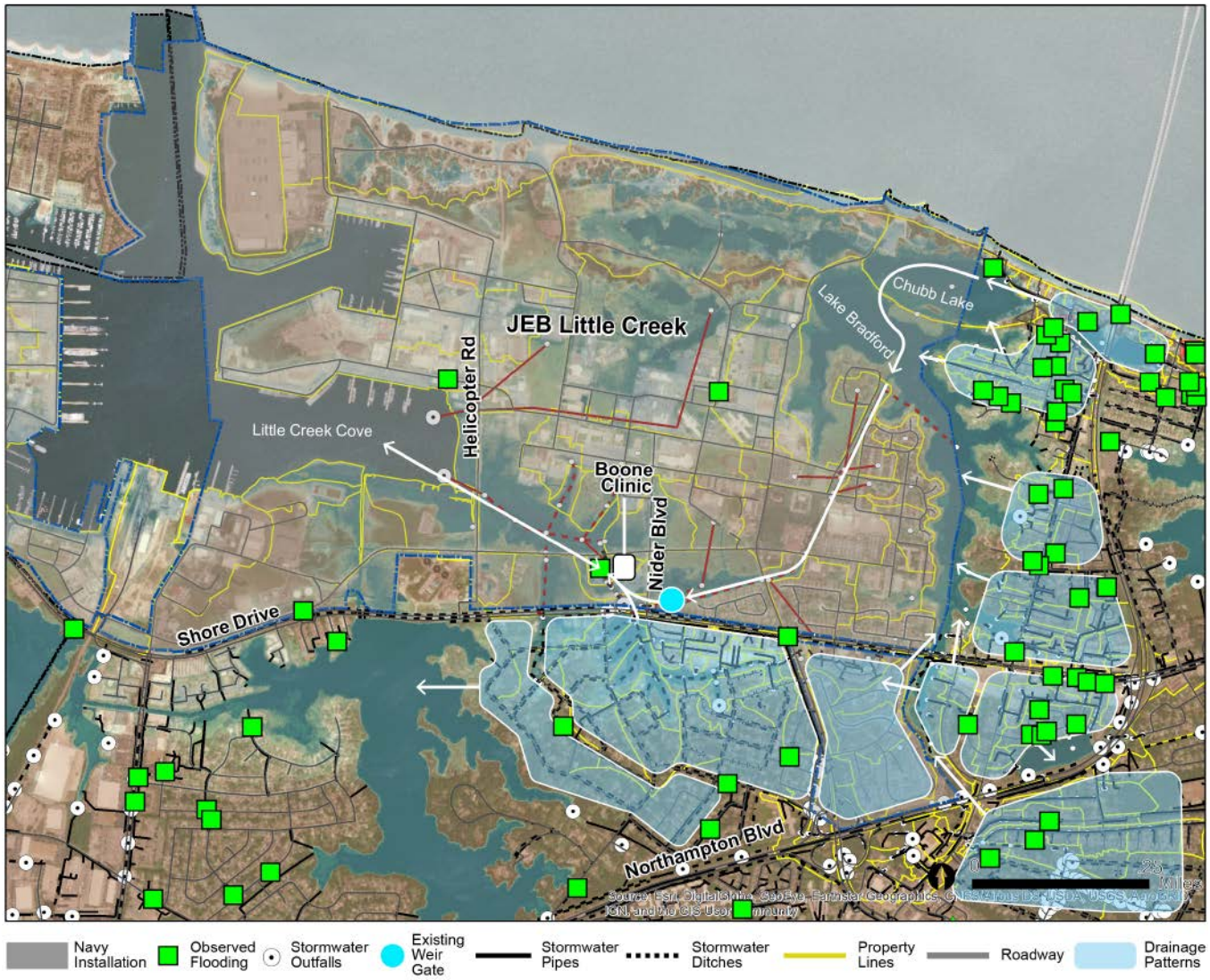

FIGURE 5-13: JEB Little Creek – Existing Conditions Diagram and Drainage Patterns Near Boone Clinic

Additionally, stormwater from Virginia Beach's Lake Shores neighborhood passes under Shore Drive before entering the same drainage ditch at the Boone Clinic, downstream of the weir gate. The Navy's and Virginia Beach's stormwater drainage systems are interconnected, and both are impacted by current tidal conditions. Ongoing sea level rise will increase the frequency and intensity with which tidal conditions hinder stormwater drainage, increasing the flooding potential on Amphibious Drive and in the neighborhoods connected by storm drain systems to Little Creek Harbor.

Virginia Beach has studies underway that directly relate to both stormwater management and tidal flooding potential in this model project's focus area. Virginia Beach's comprehensive *Stormwater Master Plan Update* efforts have produced H&H models of the drainage basins of the project area, and those models also include a schematic version of the

Navy's on-base drainage infrastructure. A separate study, explained in more detail in Chapter 3, Action #4: East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy, focuses on the management of Lake Bradford and Chubb Lake and the drainage canal and weir gate between Lake Bradford and Little Creek Harbor. The Lake Bradford and Chubb Lake study is directly relevant to this model project, and will provide valuable input for its implementation. Virginia Beach is also finalizing a study of the City's overall vulnerability to storm surge and sea level rise. While the study appears to be focusing more on extreme storm surge events, and thus may not make recommendations targeted specifically at localized stormwater management or minor tidal flooding related to the base, the analyses conducted for the study could still inform the implementation of this model project.

5.2.2 SOLUTIONS AND BENEFITS

A series of interventions are proposed to help alleviate flood conditions in the area around the Boone Clinic and to help reduce neighborhood flooding surrounding the base. These solutions aim to

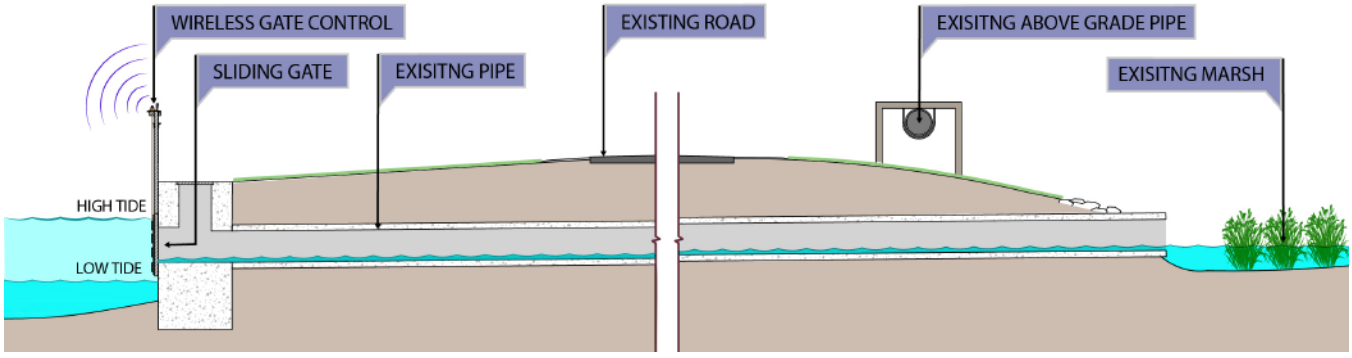

FIGURE 5-14: JEB Little Creek – Proposed Helicopter Road Tide Gate Cross Section

FIGURE 5-15: JEB Little Creek – Tide Gate Concept Design

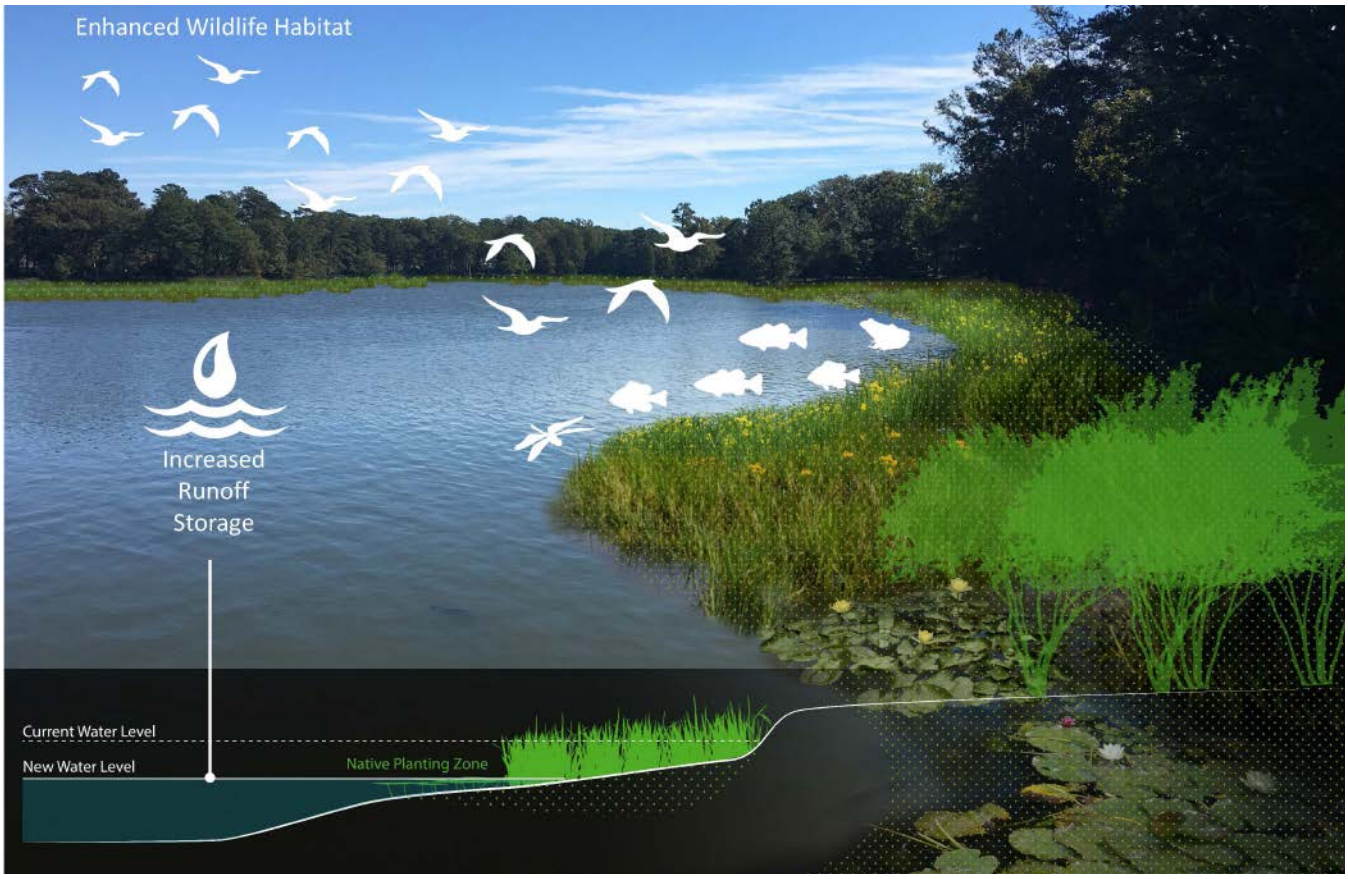

FIGURE 5-16: JEB Little Creek – Potential Benefits of Lowering Lake Bradford

increase the capacity of the system and to introduce more control points that can more effectively manage the flow of water.

The existing weir gate provides an important function by controlling drainage flowing from the lakes toward tidal wetlands of Little Creek Cove. This infrastructure should remain. A second tide gate is recommended at Helicopter Road to provide an additional level of control of tidal flow in Little Creek Cove west of Helicopter Road, and prevent high tides and minor tidal flooding from impacting Amphibious Drive and the Boone clinic parking area. **Figure 5-14** shows a cross section of how the gate could be placed to avoid operational impacts to Helicopter Road, and **Figure 5-15** shows an illustrative rendering of the concept. At low tide, ahead of an approaching storm, this control point could be closed to keep runoff storage capacity available in the area east of Helicopter Road.

The new tide gate could be wirelessly controlled by the Navy or Virginia Beach to adjust the system in preparation for or in response to heavy rain events. The new control point could also be used in combination with the weir gate to lower the levels of Lake Bradford. Lowering the typical lake level would create additional storage capacity and reduce neighborhood flooding. Lowering the level of Lake Bradford could also potentially create habitat benefits, if riparian wetlands were created. This would also address the aesthetic impacts of lowering the lake level (see **Figure 5-16**).

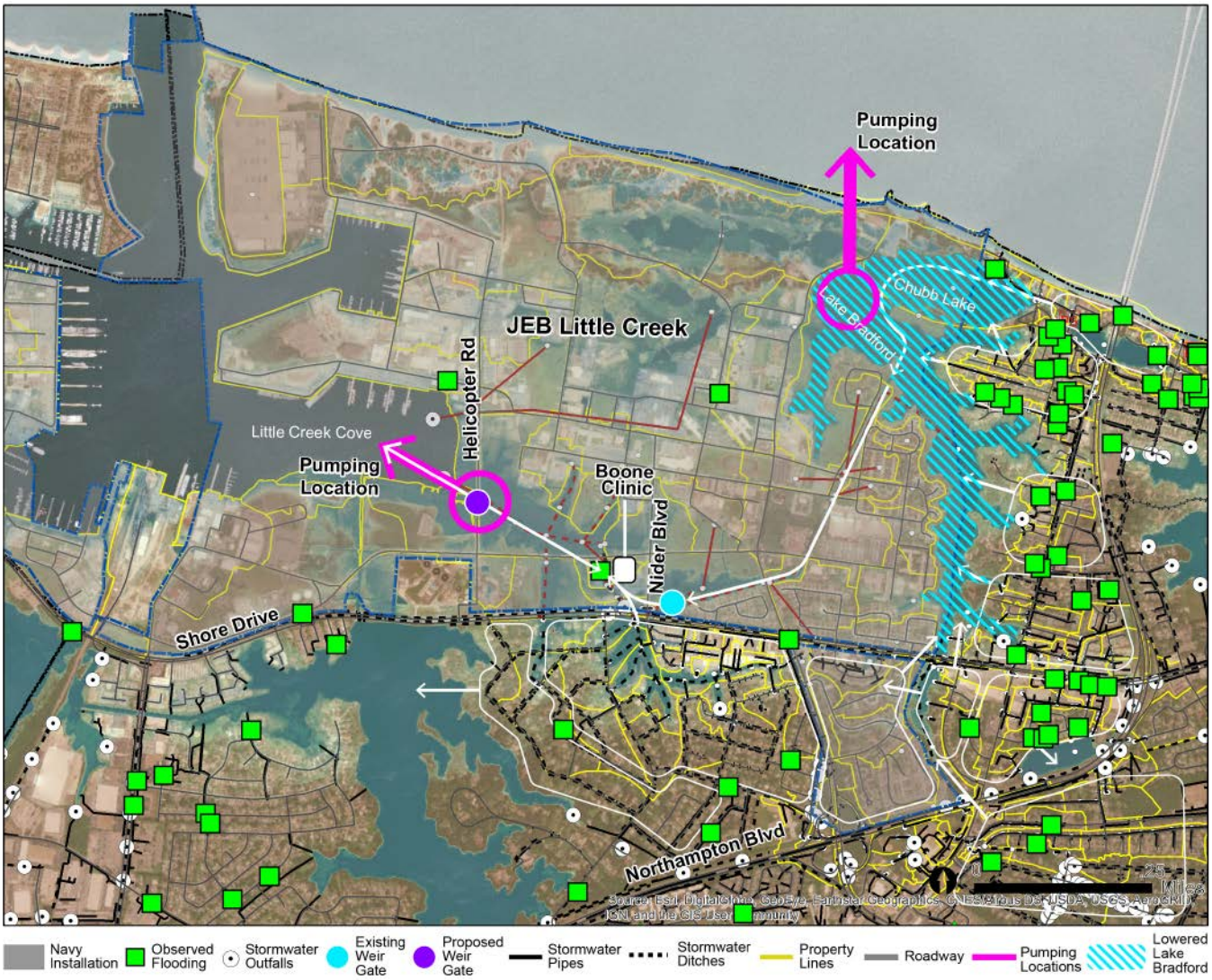

FIGURE 5-17: JEB Little Creek – Potential Pump Station Locations

An additional measure of control could be added to the system by establishing a pump station to actively lower lake levels, regardless of the tide. The pump station could either be located in Lake Bradford and pump north to the Bay, or be built along with the Helicopter Road tide gate and pump west to the inlet (see **Figure 5-17**). The optimal location and capacity of the pump station should be determined through detailed H&H study calculations that would be part of the detailed planning, engineering, and design for this type of infrastructure.

5.2.3 IMPLEMENTATION

This project would require coordination between Virginia Beach and the Navy to ensure the design, operation, and long-term infrastructure maintenance needs are identified and addressed.

In addition to studies required to further develop the design of specific features, the potential impacts of such a project on the larger area of Little Creek Harbor, upland facilities within the base, the adjacent neighborhoods, and other environmental resources should be evaluated. Much of this evaluation could be done by using existing modeling tools as a starting point, such as the Virginia Beach *Stormwater Master Plan Update* models and similar models developed for the Pretty Lake watershed and coastal area in Norfolk.

Additional recommended implementation steps and considerations include:

- Creating a joint project planning and engineering team with Navy and Virginia Beach staff, focused on data sharing, design concept development, and testing of design concepts using Virginia Beach's existing watershed models.
- Holding a project scoping meeting to confirm the project scope and available data, identify risks and concerns, and define the required level of technical analysis and environmental review.
- Developing a detailed H&H study, basis of design, and preliminary engineering designs for the control point tide gates and pump station features.
- Addressing access requirements along Helicopter Road.
- Evaluating the benefits, costs, and impacts of adding one or more pumping stations to the system to more actively maintain lake levels and allow for pumping prior to storm events (to create additional stormwater storage east of Helicopter Road).
- Engaging the residents and property owners located along Chubb Lake and Lake Bradford about the benefits of more actively controlling the water surface elevation within both lakes and inviting their feedback early in the preliminary design.
- Coordinating these efforts with other ongoing studies of the adjacent lakes and drainage basins.
- Establishing an operating agreement for the new tide gate at Helicopter Road and the existing weir gate. Lessons learned from operating the existing weir gate, and also from historical operation of the Mason Creek tide gate between NS Norfolk and Norfolk, should be incorporated into this agreement.
- Establishing a maintenance agreement between Virginia Beach and the Navy for additional cleaning/dredging of the drainage channel and for ongoing maintenance of the channel.
- Determining feasibility of additional dredging in the drainage channel, including environmental permitting and cost feasibility.

A high-level ROM cost estimate for East Amphibious Drive, Chubb Lake, and Lake Bradford flood mitigation improvements is outlined in **Table 5-4**. Additional detail and a list of assumptions are provided in the Appendix.

TABLE 5-4: HELICOPTER ROAD AND BOONE CLINIC – ROM SUMMARY

STRATEGY	APPROXIMATE COST OF ENHANCEMENTS*	ROM ASSUMPTIONS
Helicopter Road Tide Gate	$750,000	Includes 1 structure housing 3 remote-controllable sluice gates on the 3 culverts under Helicopter Road
Riparian Enhancements to Lake Bradford	$3,370,000	Riparian plantings along border of Lake Bradford
Helicopter Road Pump Station Location	$22,491,000	High-capacity pump station
Lake Bradford Pump Station Location	$8,996,000	Low-capacity pump station

*CONTINGENCY (35%) AND DESIGN/PERMITTING (12%) FEES INCLUDED

6 IMPLEMENTATION PLAN

The recommended Actions and coordination strategies outlined in the JLUS are intended to support the cities of Virginia Beach and Norfolk in their goal of ensuring the continued sustainability of the military missions at NS Norfolk, NSA Hampton Roads, NAS Oceana, Dam Neck Annex, and JEB Little Creek-Fort Story. The Actions focus on creating and maintaining resilient, reliable access throughout the study area and promote improved coordination among JLUS partners to advance regional priorities.

The planning horizon for the JLUS is 2065, based on the SLR ranges used in the analysis; however, the recommended Actions and Regional Coordination Strategies are intended to provide a roadmap for action focused on the next 10 to 15 years. The Actions reflect the fact that, in many cases, more coordinated and technical analyses are needed before an infrastructure solution can be identified, agreed upon, and pursued. Such studies can provide crucial evidentiary support for policy decisions later on, or changes in regulatory requirements. New infrastructure has a long lifespan, and while some types of infrastructure are routinely upgraded or replaced, major infrastructure projects are a significant investment that can take many years to plan, design, and build.

It is recognized that execution of projects can be driven by many different and dynamic factors such as available funding or the ability to expand a project that is already in the planning or design pipeline. These factors may allow some projects ranked lower in score to advance faster than those with a higher ranking score. Overall, any opportunity to advance a project should be embraced and not limited by project ranking.

The score of each Action defines its primary level of priority for implementation. Table 6-1 shows how the Actions break down by score ranges (high, medium, and low) and **Figure 6-1** displays the Actions in the same groupings using black, gray, and white shading on the figure reference marker. This grouping can help distinguish the higher scoring Actions more quickly.

A higher score indicates a stronger ability to address the JLUS goals and reduce overall risk to military readiness. However, other implementation factors, such as the associated SLR risk timeframe, current funding status, relevant progress on planning or design phases, and potential cost, are important factors that can influence implementation priority. These additional factors can help inform the JLUS partners as they proceed forward toward implementation and are described below.

The eight high scoring Actions, along with the Regional Coordination Strategies provide a roadmap for the JLUS partners to work together toward implementation.

TABLE 6-1: RECOMMENDED JLUS ACTIONS BY RANKING SCORE RANGE

PRIORITY RANKING	SCORE RANGE	# OF ACTIONS	RANKING COLOR (SEE FIGURE 6-1)
High	15 and above	8	Black
Medium	10–14	5	Gray
Low	9 and below	9	White

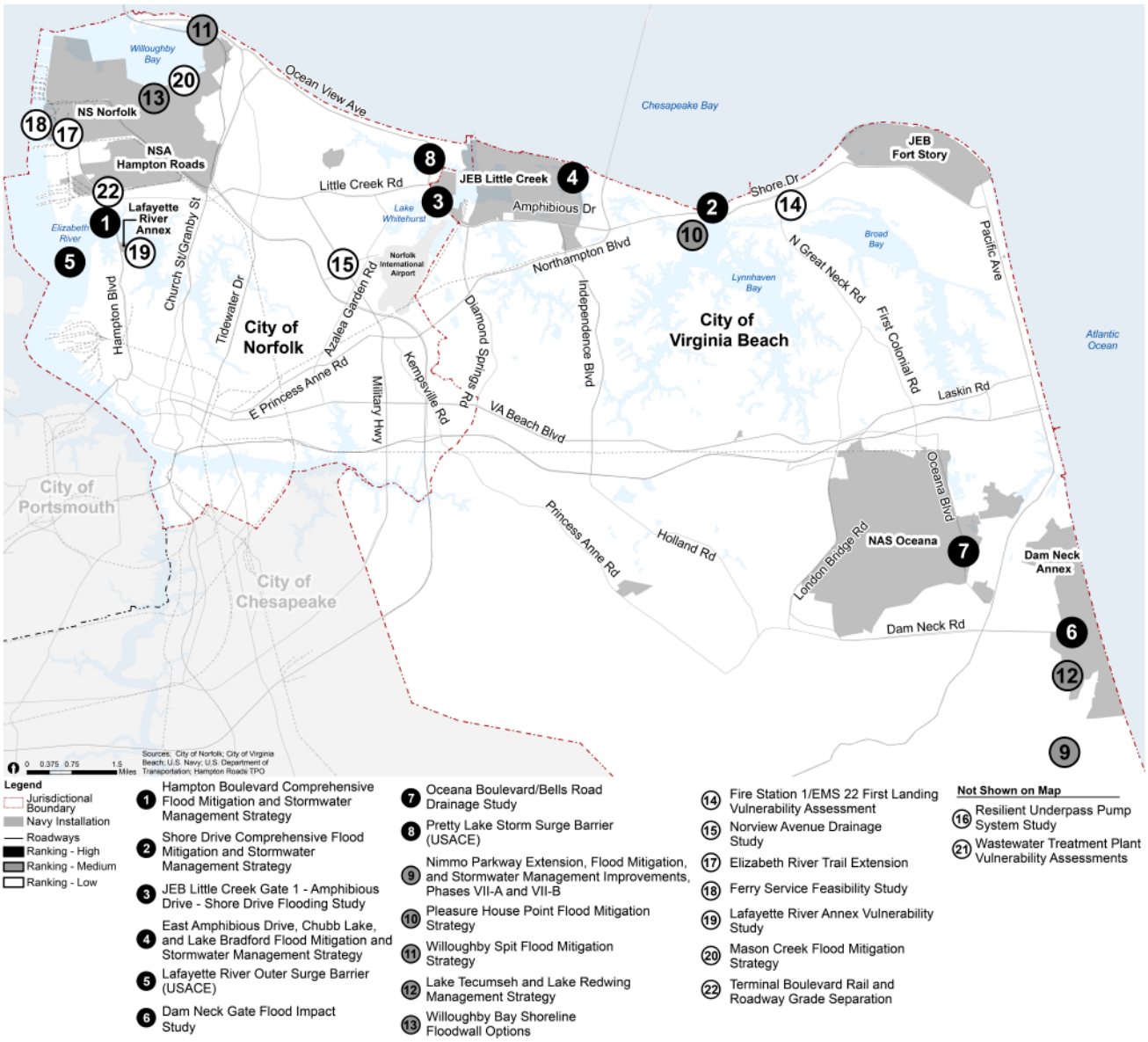

FIGURE 6-1: Recommended JLUS Actions by Ranking

Table 6-2, at the end of this chapter, provides an implementation matrix showing each Action, sorted by score, and includes information on additional factors that should be considered as a project advances. These are described in the next section and include:

- Sea level risk timeframe
- Funding and approval stages
- Responsible party and partners
- Potential funding sources

Table 6-3 provides a summary of the high-ranking Regional Coordination Strategies.

6.1 ADDITIONAL IMPLEMENTATION FACTORS

Sea Level Rise Risk Timeframe

A "sea level rise risk timeframe," which corresponds to when impacts from estimated sea level rise could be expected to occur (this does not apply to Regional Coordination Strategies), has been assigned to each Action. The anticipated timing of sea level rise impacts is a key consideration, since some flooding threats may exist now, while others will occur incrementally in the future, allowing more flexibility to plan and design for future infrastructure investments. The timeframe for future sea level rise corresponds to the sea level rise scenarios being used for this JLUS and suggests a general timeframe for implementation, with the understanding that these dates may change depending on future conditions. Given this uncertainty, it is recommended that planning for all recommended JLUS Actions begin as soon as feasible. The SLR estimated risk timeframes for each scenario are as follows:

- Minor tidal flooding with 0 feet of SLR: 2019
- 1.5 feet of SLR plus minor tidal flooding: 2035–2045
- 3.0 feet of SLR plus minor tidal flooding: 2065–2075

All of the high priority Actions have an estimated SLR risk timeframe of today. The SLR timeframe for USACE projects, including Action #5 (Lafayette River Surge Barrier), #8 (Pretty Lake Storm Surge Barrier), and Action #13 (Willoughby Bay Shoreline Floodwall Options) has been defined as "today," because of the benefits those projects would have on reducing current minor tidal flooding that is occurring now. The USACE projects were developed to address storm surge, which was not a factor in the JLUS sea level rise scenarios; however, construction of these projects would provide benefits to a number of Actions, as described in Chapter 3.

Funding and Approval Status

The majority of JLUS Actions are new Actions proposed by this study; therefore, no planning or design activities related to these Actions have begun. Likewise, funding sources for most Actions have not been identified. However, a handful of Actions from previous studies that are part of the JLUS Action list have advanced forward in planning and/or design, and some have received some level of funding toward their execution.

Figure 6-2 illustrates the various funding and approval stages and the relationship they have to each other. These factors are intended to help inform the level of effort that could be required to move an Action forward, recognizing that some Actions will be more complex than others, and funding availability may shift how Actions are prioritized to take advantage of resources.

Five funding stages are defined that range from unknown (or unidentified) to the appropriation of funding for construction. Four approval stages are defined that start with pre-planning and end with final plan or design approval.

Responsible Party and Partners

Implementation of the JLUS Actions and Regional Coordination Strategies will require leadership and support from a number of partners.

A lead responsible party has been identified along with supporting partner roles for each Action in the implementation matrices. The lead party is responsible for initiating the recommendation, working to identify and engage various project partners, and seeing the action through to completion. There may be other partners, such as non-profits, state agencies, or federal agencies, beyond those listed, that can be of support and instrumental to advancing an Action forward.

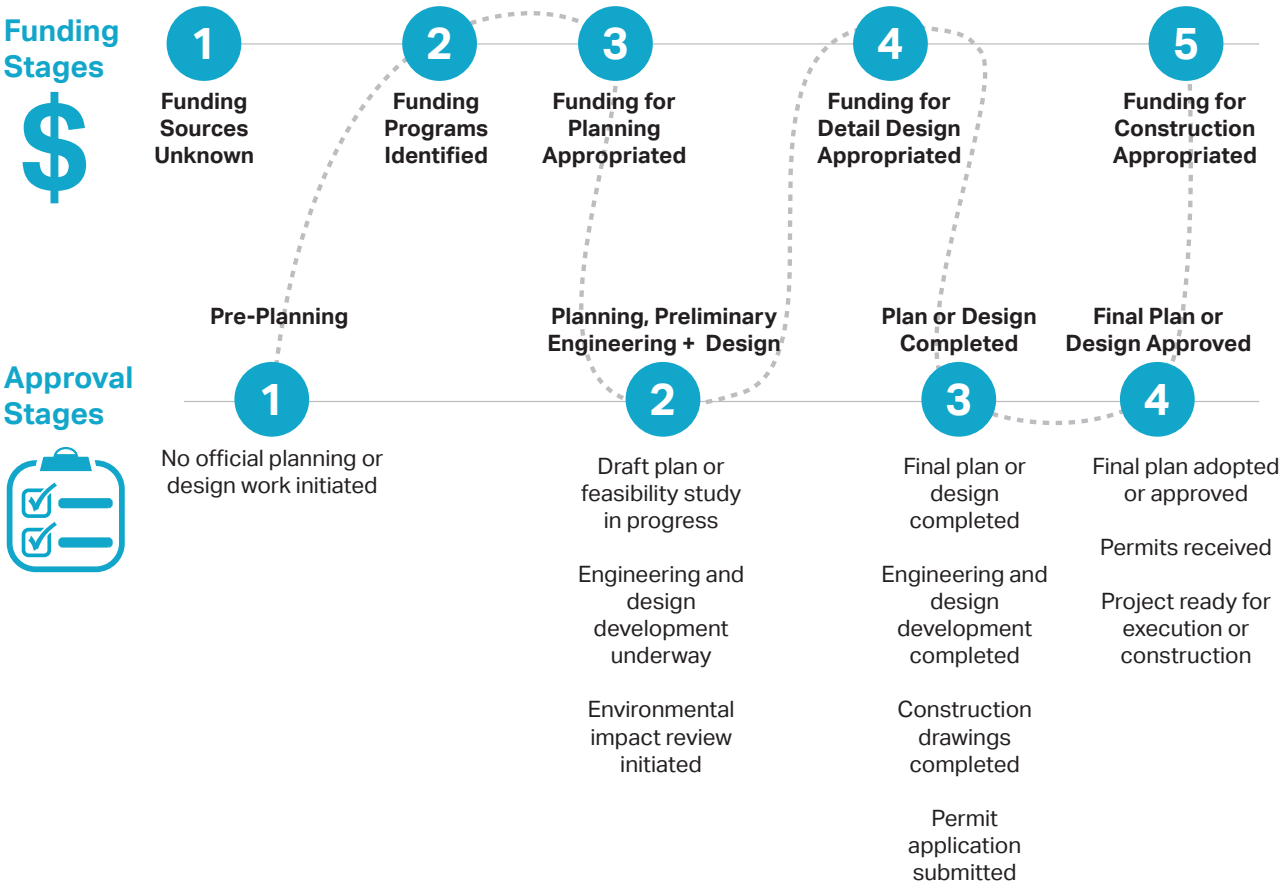

FIGURE 6-2: Funding and Approval Stages

Cost Range

Many of the Actions require additional analysis or planning before a specific design solution can be identified that meets the needs of the affected parties and the goals of the JLUS.

A defined cost range for each JLUS Action is identified in Chapter 3 and is not repeated here. The cost range reflects the potential cost of more detailed study, design, and construction for each Action. The actual cost will be influenced by many factors that are unknown at this stage of the process. These ranges, described in Chapter 3, provide an order of magnitude estimate that can be refined as project details and scoping are determined.

In addition, each Action in Chapter 3 includes a list of potential funding sources. A full list of funding sources, with website links, is included in the Appendix for reference.

TABLE 6-2: JLUS IMPLEMENTATION ACTION MATRIX

Action #	Score	Action	Sea Level Rise Time Threat	Installations Served*	Responsible Parties	Partners	Funding Stage	Approval Stage
1	19	Hampton Boulevard Comprehensive Flood Mitigation and Stormwater Management Strategy	Today (0' SLR)	NSN, NSA HR, LRA	Norfolk	U.S. Navy, VA Port Authority, VDOT, HRPDC	1	1
2	19	Shore Drive Comprehensive Flood Mitigation and Stormwater Management Strategy	Today (0' SLR)	JEB LC - FS	Virginia Beach	U.S. Navy	1	1
3	18	JEB Little Creek Gate 1 - Amphibious Drive - Shore Drive Flooding Study	Today (0' SLR)	JEB LC - FS	Norfolk, Virginia Beach	U.S. Navy, USACE, ORF	1	1
4	17	East Amphibious Drive, Chubb Lake, and Lake Bradford Flood Mitigation and Stormwater Management Strategy	Today (0' SLR)	JEB LC - FS	Virginia Beach	U.S. Navy	4	5
5	16	Lafayette River Outer Surge Barrier (USACE)	Today (0' SLR)	NSN, NSA HR, LRA	Norfolk	USACE, U.S. Navy, USCG	3	2
6	15	Dam Neck Gate Flood Impact Study	Today (0' SLR)	NAS Oceana-Dam Neck	Virginia Beach	U.S. Navy	1	1
7	15	Oceana Boulevard/Bells Road Drainage Study	Today (0' SLR)	NAS Oceana-Dam Neck	Virginia Beach	U.S. Navy	1	1
8	15	Pretty Lake Storm Surge Barrier (USACE)	Today (0' SLR)	JEB LC - FS	Norfolk	USACE, U.S. Navy, USCG	1	2
9	14	Nimmo Parkway Extension, Flood Mitigation, and Stormwater Management Improvements, Phases VII-A and VII-B	Today (0' SLR)	NAS Oceana-Dam Neck	Virginia Beach	N/A	1	1
10	14	Pleasure House Point Flood Mitigation Strategy	Today (0' SLR)	JEB LC - FS	Virginia Beach	N/A	1	1
11	14	Willoughby Spit Flood Mitigation Strategy	Today (0' SLR)	NSN	Norfolk	N/A	1	2
12	11	Lake Tecumseh and Lake Redwing Management Strategy	Today (0' SLR)	NAS Oceana-Dam Neck	Virginia Beach	U.S. Navy	1	1
13	11	Willoughby Bay Shoreline Floodwall Options	Today (0' SLR)	NSN	U.S. Navy	Norfolk	1	2
14	9	Fire Station 1/EMS 22 First Landing Vulnerability Assessment	Today (0' SLR)	JEB LC - FS	Virginia Beach	N/A	1	1
15	9	Norview Avenue Drainage Study	Today (0' SLR)	JEB LC - FS	Norfolk	ORF	1	1

TABLE 6-2: JLUS IMPLEMENTATION ACTION MATRIX (continued)

Action #	Score	Action	Sea Level Rise Time Threat	Installations Served*	Responsible Parties	Partners	Funding Stage	Approval Stage
16	9	Resilient Underpass Pump System Study	Today (0' SLR)	NSN, NSA HR, LRA	Norfolk	VDOT	1	1
17	8	Elizabeth River Trail Extension	2040 (1.5' SLR)	NSN, NSA HR, LRA	Norfolk, Elizabeth River Trail Foundation	U.S. Navy, VA Port Authority	4	4
18	8	Ferry Service Feasibility Study	2040 (1.5' SLR)	NSN, NSA HR, LRA	HRT	U.S. Navy, VA Port Authority, Norfolk	1	1
19	8	Lafayette River Annex Vulnerability Study	Today (0' SLR)	LRA	U.S. Navy	Norfolk	1	1
20	8	Mason Creek Flood Mitigation Strategy	Today (0' SLR)	NSN	Norfolk	U.S. Navy	1	1
21	8	Wastewater Treatment Plant Vulnerability Assessments	2040 (1.5' SLR)	NSN, NSA HR, LRA, JEB LC - FS, NAS Oceana-Dam Neck	HRSD	Norfolk, Virginia Beach	1	1
22	7	Terminal Boulevard Rail and Roadway Grade Separation	Today (0' SLR)	NSN, NSA HR, LRA	HRTPO	Norfolk, VDOT, U.S. Navy, VA Port Authority	2	2

***Acronyms Used in Table 6-2**

NSN - Naval Station Norfolk

NSA HR - Naval Support Activity Hampton Roads

LRA - Lafayette River Annex

JEB LC-FS - Joint Expeditionary Base Little Creek - Fort Story

TABLE 6-3: REGIONAL COORDINATION STRATEGY IMPLEMENTATION MATRIX

#	STRATEGY	RESPONSIBLE PARTY	PARTNERS
Coordination and Outreach Strategies			
1	Adopt a MOU among JLUS partners to commit to working together to advance and implement JLUS priorities and establish a JLUS Implementation Committee as an outcome of the MOU.	HRPDC	Norfolk, Virginia Beach, U.S. Navy
2	Coordinate on Navy access control point (gates) projects and establish Navy policy to consider transit as part of new and redesigned gate access projects.	U.S. Navy	Port Authority
3	Develop a stormwater systems maintenance MOU for each installation and respective locality to define ongoing roles and responsibilities for routine maintenance of ditches, culverts, and other drainage components that span locality/Navy jurisdiction.	Norfolk, Virginia Beach	U.S. Navy
4	Encourage utility providers to provide regular updates on infrastructure upgrades. Define clear communication protocols and points of contact between local utilities, private providers (Dominion, VA Natural Gas), and the Navy to improve coordination on projects and expedite action during emergency events.	HRPDC	Norfolk, Virginia Beach, U.S. Navy
5	Establish coordination protocols between city floodplain managers and Navy support personnel to share information about flood risk, flood insurance, existing city programs, and floodplain development regulations.	Norfolk, Virginia Beach	U.S. Navy
6	Develop outreach materials for DoD personnel about the flood risks in the area; incorporate into city programs (Know your Watershed) and Navy briefings to families; disseminate through Fleet and Family Services (target military spouses).	U.S. Navy	
7	Update the *Military Commuter Survey* (HRTPO) to address issues related to flooding and sea level rise and how these issues affect overall access to work and other services.	HRTPO	
Advocacy Strategies			
8	Encourage Congress to appropriate funding for the DCIP.	JLUS Partners	HRPDC
9	Encourage the DoD to require that proposed projects be identified in a JLUS to be eligible for DCIP funding and to use criteria consistent with this study's methodology to evaluate candidate projects.	HRPDC	U.S. Navy
10	Pursue an amendment to the VDOT Smart Scale criteria to include sea level rise, flooding, and military readiness as factors for prioritizing projects for funding.	HRTPO	Norfolk, Virginia Beach, U.S. Navy
11	Pursue an amendment to the Code of Virginia and the Virginia Residential Property Disclosure Act for mandatory disclosure requirements for flood hazard for real estate transactions (purchase and rental).	HRPDC	Norfolk, Virginia Beach, U.S. Navy
Policy/Development Regulations Strategies			

TABLE 6-3: REGIONAL COORDINATION STRATEGY IMPLEMENTATION MATRIX (continued)

#	STRATEGY	RESPONSIBLE PARTY	PARTNERS
12	Adopt the recommended regional policy for incorporating sea level rise into planning and engineering decisions, or similar policy.	Norfolk, Virginia Beach	HRPDC
13	Implement a cumulative substantial improvement provision for tracking improvements to structures in the flood hazard area over a pre-determined period, such as 5 or 10 years.	Norfolk, Virginia Beach	
14	Strengthen repetitive loss definitions in local floodplain management ordinances to provide added protections to insured property owners.	Norfolk, Virginia Beach	
15	Require a recorded declaration of land restriction to disclose flood risk location information and to highlight the prohibition of converting areas under elevated structures to habitable space.	Norfolk, Virginia Beach	
16	Develop regional guidance for incorporating flooding and SLR into city capital planning projects to ensure that all projects adequately address flooding and sea level rise vulnerability, risk, and adaptation.	HRPDC	Norfolk, Virginia Beach
17	Request that state agencies incorporate Hampton Roads regional guidance, or similar policy, for flooding and SLR into all state-level capital planning projects and studies.	HRPDC	
18	Continue to update and revise Comprehensive Plans, Zoning Ordinances, and variance requirements to align land use, density, height restrictions, open space requirements, setbacks, and other building restrictions to limit density of future development or post-disaster redevelopment in areas where flood risk is highest now and in the future.	Norfolk, Virginia Beach	
19	Consider risks associated with flooding and SLR as part of any comprehensive or area plan update and evaluate options to address those neighborhoods where access to community assets could be affected by flooding and SLR.	Norfolk, Virginia Beach	
Technology and Data			
20	Support use of the Hampton Roads Geospatial Exchange Online (http://www.hrgeo.org/) as a regional portal to share modeling data and projections, sensor networks and data, GIS data, streamline access to technical studies, share scripts and codes, and test apps for improving information dissemination.	Norfolk, Virginia Beach	HRPDC
21	Define GIS data sharing protocols, requirements, and points of contact at cities and Navy to support cross-jurisdictional technical studies, analyses, and project execution.	HRPDC	Norfolk, Virginia Beach, U.S. Navy
22	Make Storm Sense operational as a forecasting tool and pursue long-term funding for maintenance and operation.	HRPDC	
23	Adopt a regional-serving alert system that incorporates flood warning information, and explore new technologies to pilot warning systems. Ensure system includes and works with DoD and Virginia Port Authority systems.	HRPDC	Norfolk, Virginia Beach, U.S. Navy

APPENDIX

A. OTHER ISSUES

During the JLUS stakeholder interview process, several other important issues were identified that are outside the scope of the JLUS and its direct focus on flooding and sea level rise. These issues are either already being addressed, or could be pursued through a separate study and are described below.

1. Navy and Virginia Port Authority coordination

The installation of new and larger cranes at NIT to support incoming Panamax ships has the potential to impact NS Norfolk airfield operations. Coordination during obstruction evaluations is required to avoid or minimize impacts on Chambers Field at NS Norfolk associated with the new proposed 453 foot cranes. A process is currently underway involving the Virginia Port Authority, Navy, and Federal Aviation Administration (FAA) to assess impacts. This issue exemplifies the need for the Port Authority and the Navy to have established communication protocols in place to allow concerns to be identified early related to any redevelopment project or activity that could potentially impact military operations.

2. Federal Navigation Channel expansion and increased barge traffic

The USACE and the Virginia Port Authority completed an integrated *General Reevaluation Report and Environmental Assessment* (GRR) on June 29, 2018, which recommended the Norfolk Harbor Navigation Channels be widened and deepened to accommodate larger and deeper ships making port calls in Hampton Roads.[1] The navigation project secured full federal approval when President Trump signed the America's Water Infrastructure Act of 2018.[2]

The proposed dredging and widening of the Elizabeth River channel will support the larger Panamax cargo vessels and will be accompanied by increased barge traffic that could potentially conflict with ship and boat traffic from other channel users, including the Navy. Increased coordination and defined protocols between the USCG, the Navy, and the Virginia Port Authority will be required to de-conflict traffic and minimize the impact on Navy operations at NS Norfolk.

3. Coastal training

The Navy maintains several assets that support the mission of training, evaluation, and testing operations that rely on coastal training areas. Issues that can impact these assets include recreational boating, shoreline replenishment projects, and shipping channel activities.

A specific issue was identified at the entrance to Little Creek Harbor, which serves JEB Little Creek, the USCG, and several nearby private marinas. Recreational boaters entering Little Creek Harbor sometimes veer off course, or travel at increased speeds, towards areas that are off-limits to civilians. This condition creates security concerns for the installation. A no-wake zone would reduce security threats; this approach would need to also consider the requirements of the Navy, USCG, as well as the civilian boating community.

Recreational boating and fishing is a popular activity in the study area that sometimes conflicts with Navy operations. At Dam Neck Annex, the shooting range safety danger zones extend into the water and if a boater enters the restricted area, operations must

1 "Norfolk Harbor Navigation Improvements." Nao.usace.army.mil. April 30, 2018. https://www.nao.usace.army.mil/About/Projects/Norfolk-Harbor-Channel-Deepening/.
2 Little, Vince. "USACE, Port of Virginia ramp up Norfolk Harbor deepening efforts." Nao.usace.army.mil. January 24, 2019. https://www.nao.usace.army.mil/Media/News-Stories/Article/1739330/usace-port-of-virginia-ramp-up-norfolk-harbor-deepening-efforts/.

cease until the area is cleared. Similarly, boater intrusion occasionally occurs in the surface danger zones of the Little Creek firing range. Both of these assets are critical to operations.

The Navy works with the Port Authority and USCG to ensure access to coastal training areas when needed, including the Wysocki Drop Zone located offshore of Fort Story. The drop zone overlaps with the USCG managed Naval Anchorage Area A. All training activities occurring within the Wysocki Drop Zone require coordination with the USCG to ensure there are no conflicts with ships transiting to and from or berthed at the anchorage and Navy operations. The USCG is looking for alternative areas for anchorage, especially in light of increasing shipping traffic.

4. Norfolk International Airport Expansion

The proposed second parallel runway at Norfolk International Airport would require 67 acres of fill in Lake Whitehurst, and would directly impact operations at JEB Little Creek. There is also concern that additional fill in the lake could contribute to flooding issues in the area and on the base. According to airport officials, milling and overlaying the existing runway would allow the airport to remain operational for 10 to 12 years, at most, before the entire runway will have to be replaced. If there is no alternate/parallel runway available, the airport would not be able to support commercial carrier operations for the duration of the construction of the replacement runway, which would impact air travel and cargo transport in the region.[3]

A formalized working partnership between Norfolk, Virginia Beach, Norfolk International Airport, the Navy, and any other relevant stakeholders is needed to coordinate and implement a study that analyzes the impacts of the proposed additional runway on military operations. This study could also incorporate findings from JLUS Action #4, Amphibious Drive Technical Hydrology/Hydraulic Study. This action calls for a detailed modeling study of all of the stormwater drainage pathways converging on Little Creek Harbor, plus the tidal and storm surge effects from the Chesapeake Bay, and would allow the cities and the installation to determine the cause of the recurrent flooding on Amphibious Drive – including any interactions from Lake Whitehurst.

5. Neighborhood cut-through traffic

Some neighborhoods adjacent to NS Norfolk experience cut-through traffic from people trying to access the gates more quickly. Specific concerns were raised about this issue near gates 10 and 12 at NS Norfolk. Gates 10 and 12 are heavily-used entrance points to NS Norfolk, and congestion causes vehicles to back up at the gates. This situation can sometimes impede access to adjacent neighborhood streets, and/or can lead to vehicles taking alternate routes through adjacent neighborhoods to avoid the congestion. The surrounding neighborhoods are home to both military personnel and civilians. Cut-through traffic can impact their ability to get into and out of their homes and contribute to safety concerns. Additionally, the gates are located in an area that could see additional flooding impacts from minor tidal flooding under a 1.5-foot SLR scenario. Norfolk should develop a close working partnership with the Navy, and undertake a study to evaluate current traffic movements in the surrounding neighborhoods and at the gates. The study should explore a range options that may include, but are not limited to: increased enforcement, signage, re-routing of traffic, or modifying or moving gate access.

3 Adhikusuma, Briana. "Runway rehabilitation could curtail Norfolk airport's capacity." *The Virginian Pilot*, July 31, 2017. https://pilotonline.com/inside-business/news/maritime-and-transportation/article_0b0d1109-2b51-5300-a004-3a0e9a4ccbb7.html.

B. RECOMMENDED CONVERSATIONS

Recommended "Conversations" involve issues that have arisen during JLUS stakeholder interviews and discussions with the Technical and Policy Committees that require further exploration before they can become implementable actions. These conversations, identified in **Table A-1**, will require the responsible parties and partners to come together and discuss the issues and determine how best to proceed.

1. Consider options for a flood mitigation project at Little Creek Inlet. Little Creek Inlet is a heavily-utilized waterway that connects Little Creek with the Chesapeake Bay. During storm and tidal events, flooding from the Chesapeake Bay can overwhelm the inlet and adjacent land areas, which include the JEB Little Creek installation, residential neighborhoods, and commercial areas. Little Creek Harbor, at the mouth of the inlet, is used by JEB Little Creek to dock ships and perform training exercises. There is also a Coast Guard patrol station located in the harbor, and a private marina that serves the community immediately adjacent to the Harbor on the western side, so private boats utilize the inlet for access to and from the Chesapeake Bay on a regular basis. Because the inlet opens up the surrounding area to tidal/storm surge flooding, a flood mitigation

TABLE A-1: RECOMMENDED CONVERSATIONS

Conversation Description	Sea Level Rise Time Threat	Responsible Party	Project Partner
1. Consider options for a flood mitigation project at Little Creek inlet	2040 (1.5' SLR)	Navy	Virginia Beach, USACE, USCG
2. Consider options for a flood mitigation project at Lynnhaven River inlet	2040 (1.5' SLR)	Virginia Beach	USACE, Navy
3. Consider options for flood mitigation project at Long Creek inlet	2040 (1.5' SLR)	Virginia Beach	USACE
4. Explore options for reusing Chesapeake-Elizabeth WWTP for stormwater storage	2040 (1.5' SLR)	Navy	HRSD
5. Investigate Alternative Options to Fuel-Based Generators Used on Installations	Today (0' SLR)	Navy	Dominion Energy
6. Evaluate Potential for Renewable Energy Agreements Between Navy and Dominion Energy	Today (0' SLR)	Navy	Dominion Energy
7. Explore options for the long-term use of the "bisect property" on JEB Little Creek	Today (0' SLR)	Navy	

project there would benefit the surrounding community. However, efficient access into and out of the harbor is critical for mission readiness for both the Navy and Coast Guard, so any type of flood barrier or gate that installed there could present a major obstacle. Therefore, multiple options will need to be considered to mitigate flood risk to the surrounding properties and roadways that do not negatively impact Navy or Coast Guard operations. In January 2019, Virginia Beach sent a letter to the USACE requesting that this area be included in a Coastal Storm Risk Management (CSRM) feasibility study (a "3x3x3" study), as authorized under the NDAA for Coastal Virginia, to determine which measures would be feasible in the short-to-mid-term, from a cost/benefit perspective.[4]

2. Consider options for a flood mitigation project at Lynnhaven River inlet. Flooding of the roadways and properties adjacent to the Lynnhaven River inlet in Virginia Beach is an ongoing issue, which will only worsen as sea levels continue to rise. Virginia Beach's draft *Comprehensive Sea Level Rise and Flooding Study* recommends an alignment of multiple coastal protection measures at and adjacent to the Lynnhaven River Inlet that include floodwalls, sheet piles, dunes, and a sector gate at the inlet itself. These measures would address the storm surge and tidal flooding that occur at this location today, and would account for additional sea level rise. However, this project as proposed would most likely be very costly, with a long implementation timeframe. Therefore, the JLUS recommends additional conversations between the JLUS partners about how to design and implement a comprehensive flood mitigation strategy at this location that would be phased to allow for at least some protection in the short-to-mid-term, as well as in the long-term. In January 2019, Virginia Beach sent a letter to the USACE requesting that this area be included in a Coastal Storm Risk Management (CSRM) feasibility study (a "3x3x3" study), as authorized under the NDAA for Coastal Virginia.[5]

3. Consider options for flood mitigation project at Long Creek inlet Consider options for a flood mitigation project at Long Creek inlet. Tidal and storm surge flooding from Long Creek inlet, adjacent to the Lynnhaven River Inlet on the eastern side, can impact the homes and businesses both north and south of Long Creek. A densely-developed segment of Shore Drive runs north of Long Creek and there is a residential neighborhood that runs along the south side. A comprehensive flood mitigation strategy at Long Creek Inlet could help prevent "back flooding" that could occur if and when water levels increase significantly in the Lynnhaven River. Virginia Beach's draft *Comprehensive Sea Level Rise and Flooding Study* recommends exploring options for a potential coastal protection alignment at this location. In January 2019, the City of Virginia Beach sent a letter to the USACE requesting that this area be included in a Coastal Storm Risk Management (CSRM) feasibility study (a "3x3x3" study), as authorized under the NDAA for Coastal Virginia.[6]

4. Explore options for reusing Chesapeake-Elizabeth Waste Water Treatment Plan for stormwater storage. HRSD plans to "mothball" the Chesapeake-Elizabeth wastewater treatment plant, located on JEB Little Creek in 2021. Because the facility will no longer be used for wastewater treatment, the JLUS recommends that the Navy work with Virginia Beach to explore whether the facility could be used to for stormwater storage, which could potentially help alleviate flooding on Amphibious Drive, the main roadway connecting the east and west sides of the base. A study could be initiated to explore the feasibility of this concept.

4 Letter from David L. Hansen, City Manager for the City of Virginia Beach, to Colonel Patrick V. Kinsman, USACE Norfolk District Commander, dated January 19, 2019, requesting startup of a 3x3x3 study for Virginia Beach in Fiscal Year 2020.
5 Ibid
6 Ibid

5. Investigate Alternative Options to Fuel-Based Generators Used on Installations. Currently, many Navy installations use fuel-based back-up generators to provide power to critical facilities in the event of a power outage. While most installations typically have some fuel supply on base, in an extended power outage, fuel supply could become a concern if outside sources are required. This concern could be amplified if access routes to deliver fuel to the installations are flooded. The JLUS recommends that the Navy investigate alternative options to increase redundancy for back-up power for this reason.

6. Evaluate Potential for Renewable Energy Agreements Between Navy and Dominion Energy. The Navy has two solar array facilities: one at NS Norfolk and one at NAS Oceana. The existing interconnect agreements between the Navy and Dominion Energy were not assessed, but stakeholder input suggested that agreements for future solar installations could provide enhanced benefits for energy security for the host base. Future agreements could allow the Navy direct access to power from a solar arrays built on an installations. This would allow the Navy to have access to a renewable, resilient energy source that could be used as a back-up source of power, in the event that the municipal power grid was disrupted. Additionally, unused energy generated by these solar arrays could be stored in backup batteries, to be used in the event that the arrays were compromised or not functioning, providing the installation with further energy security.

7. Explore options for the long-term use of the "bisect property" on JEB Little Creek. This property, located along Amphibious Drive, is surrounded by the JEB Little Creek installation fenceline on three sides. The property is currently being used by VDOT as a staging area for roadway construction. This property's strategic location could provide an opportunity for siting additional stormwater management infrastructure, to provide the base with additional stormwater storage capacity in an area prone to recurrent flooding.

C. ADDITIONAL REGIONAL COORDINATION STRATEGIES

In addition to the high priority regional coordination strategies discussed in Chapter 4, other suggestions to improve coordination are noted below. These strategies were considered lower in priority but are included here for reference.

- Pursue regular joint briefings to the Joint Subcommittee on Coastal Flooding and other state entities to promote an understanding of JLUS issues and priorities.
- Through the JLUS implementation committee structure, provide briefings to review results of current drainage and SLR studies. Such studies may offer additional project partnering opportunities that could also be considered as JLUS priorities.
- Invite city managers, council members, and department heads to an annual briefing about Navy installation real property priorities and to identify those actions which require coordination and support.
- Establish coordinated emergency management and evacuation policies across localities modeled after Virginia Beach's approach and formalize joint installation/locality emergency management teams. Ensure DoD is invited to the All Hazards Advisory Committee.
- Define, document, and communicate a Navy installation development review process for development projects that occur outside the installation and trigger a Navy review requirement. The process should define internal Navy review timelines, a data-requirement checklist to enable the Navy's review, and points of contact for the Navy.
- Establish a dedicated Military Liaison position for the City of Virginia Beach.
- Hold annual meeting on beach replenishment work underway on Chesapeake Bay front areas to identify potential opportunities for collaboration and cost savings.
- Establish regional protocols (local government and Navy) for collecting and recording damage from flood events to allow consistent reporting and analysis.
- The Navy should hold annual briefings in each city to communicate installation priorities and to jointly discuss where regional coordination is needed or would be beneficial. This level of coordination may lead to enhanced outcomes for both the Navy and the cities.

D. FLOOD RISK DISCLOSURE

The Commonwealth currently follows a "buyer-beware" legal doctrine with regard to many forms of purchase contracts. The Virginia Residential Property Disclosure Act does not require seller disclosure of known flood risk determination or the flood history of structures. And while the mandatory purchase of flood insurance is disclosed at closing for certain loans, this communication comes late in the purchase process, after the buyer has put down earnest money. The absence of flood hazard information before closing can and does result in delays, and even cancellation, of real estate transactions due to lack of sufficient funds to escrow flood insurance.

Similarly, the Virginia Residential Landlord and Tenant Act does not currently require flood hazard disclosures. Renters in Virginia are subject to the goodwill of landlords to learn of flood hazards. Navy personnel who are unexpectedly impacted by floods, and who do not have the protections afforded by flood insurance coverage for structure or contents, are more likely to be out of work or have family-related impacts than those who are insured for flood damage and can recover more quickly. This problem can be especially acute for Navy personnel unfamiliar with the area, the local flood risk, and the area's history of flood events.

The Virginia Coastal Policy Clinic documented flood hazard disclosure laws in seven states as of 2014: California, Illinois, Iowa, New York, Maryland, Delaware, and Florida. Several other states have disclosure laws regarding flood hazards, with notably stringent requirements in Oklahoma, Louisiana, and Alabama. Example flood disclosure forms from Florida, North Carolina, and Delaware are included at the end of this section.

An amendment to the Virginia Residential Property Disclosure Act that requires either the seller or real estate agent to provide detailed disclosure of flood risk location information and a property's flood history would provide full transparency to buyers. The change would have a significant, positive impact on Navy personnel (active, reserve, and retired) moving to the Hampton Roads region who plan on purchasing real estate. A similar amendment to the Virginia Residential Landlord and Tenant Act would help protect transient Navy renters from being burdened by unwanted flood impacts.

The Residential Property Disclosure Act would need specific amendments to remove the "buyer beware" clauses at §55.519(10), and then add an affirmative disclosure in a new §55-519.5, similar to the other affirmative disclosures for proximity to military air installations, defective drywall, and pending building or zoning violations. The Residential Landlord and Tenant Act at §55-248 should also be amended with an affirmative disclosure requirement for flood risk location and flood history in a new §55-248.12:4.

STATE OF NORTH CAROLINA
RESIDENTIAL PROPERTY AND OWNERS' ASSOCIATION DISCLOSURE STATEMENT

Instructions to Property Owners

1. The Residential Property Disclosure Act (G.S. 47E) ("Disclosure Act") requires owners of residential real estate (single-family homes, individual condominiums, townhouses, and the like, and buildings with up to four dwelling units) to furnish buyers a Residential Property and Owners' Association Disclosure Statement ("Disclosure Statement"). This form is the only one approved for this purpose. A disclosure statement must be furnished in connection with the sale, exchange, option, and sale under a lease with option to purchase where the tenant does not occupy or intend to occupy the dwelling. A disclosure statement is not required for some transactions, including the first sale of a dwelling which has never been inhabited and transactions of residential property made pursuant to a lease with option to purchase where the lessee occupies or intends to occupy the dwelling. For a complete list of exemptions, see G.S. 47E-2.

2. You must respond to each of the questions on the following pages of this form by filling in the requested information or by placing a check (√) in the appropriate box. In responding to the questions, you are only obligated to disclose information about which you have actual knowledge.

   a. If you check "Yes" for any question, you must explain your answer and either describe any problem or attach a report from an attorney, engineer, contractor, pest control operator or other expert or public agency describing it. If you attach a report, you will not be liable for any inaccurate or incomplete information contained in it so long as you were not grossly negligent in obtaining or transmitting the information.

   b. If you check "No," you are stating that you have no actual knowledge of any problem. If you check "No" and you know there is a problem, you may be liable for making an intentional misstatement.

   c. If you check "No Representation," you are choosing not to disclose the conditions or characteristics of the property, even if you have actual knowledge of them or should have known of them.

   d. If you check "Yes" or "No" and something happens to the property to make your Disclosure Statement incorrect or inaccurate (for example, the roof begins to leak), you must promptly give the buyer a corrected Disclosure Statement or correct the problem.

3. If you are assisted in the sale of your property by a licensed real estate broker, you are still responsible for completing and delivering the Disclosure Statement to the buyers; and the broker must disclose any material facts about your property which he or she knows or reasonably should know, regardless of your responses on the Disclosure Statement.

4. You must give the completed Disclosure Statement to the buyer no later than the time the buyer makes an offer to purchase your property. If you do not, the buyer can, under certain conditions, cancel any resulting contract (See **"Note to Buyers"** below). You should give the buyer a copy of the Disclosure Statement containing your signature and keep a copy signed by the buyer for your records.

Note to Buyer: If the owner does not give you a Residential Property and Owners' Association Disclosure Statement by the time you make your offer to purchase the property, you may under certain conditions cancel any resulting contract without penalty to you as the buyer. To cancel the contract, you must personally deliver or mail written notice of your decision to cancel to the owner or the owner's agent within three calendar days following your receipt of the Disclosure Statement, or three calendar days following the date of the contract, whichever occurs first. However, in no event does the Disclosure Act permit you to cancel a contract after settlement of the transaction or (in the case of a sale or exchange) after you have occupied the property, whichever occurs first.

5. In the space below, type or print in ink the address of the property (sufficient to identify it) and your name. Then sign and date.

Property Address: _____

Owner's Name(s): _____

Owner(s) acknowledge(s) having examined this Disclosure Statement before signing and that all information is true and correct as of the date signed.

Owner Signature: _____ Date _____ , _____

Owner Signature: _____ Date _____ , _____

Buyers acknowledge receipt of a copy of this Disclosure Statement; that they have examined it before signing; that they understand that this is not a warranty by owners or owners' agents; that it is not a substitute for any inspections they may wish to obtain; and that the representations are made by the owners and not the owners' agents or subagents. Buyers are strongly encouraged to obtain their own inspections from a licensed home inspector or other professional. As used herein, words in the plural include the singular, as appropriate.

Buyer Signature: _____ Date _____ , _____

Buyer Signature: _____ Date _____ , _____

REC 4.22
REV 7/18

Property Address/Description: _____

The following questions address the characteristics and condition of the property identified above about which the owner has *actual knowledge*. Where the question refers to "dwelling," it is intended to refer to the dwelling unit, or units if more than one, to be conveyed with the property. The term "dwelling unit" refers to any structure intended for human habitation.

	Yes	No	No Representation
1. In what year was the dwelling constructed? _____ . Explain if necessary: _____			☐
2. Is there any problem, malfunction or defect with the dwelling's foundation, slab, fireplaces/chimneys, floors, windows (including storm windows and screens), doors, ceilings, interior and exterior walls, attached garage, patio, deck or other structural components including any modifications to them?	☐	☐	☐
3. The dwelling's exterior walls are made of what type of material? ☐ Brick Veneer ☐ Wood ☐ Stone ☐ Vinyl ☐ Synthetic Stucco ☐ Composition/Hardboard ☐ Concrete ☐ Fiber Cement ☐ Aluminum ☐ Asbestos ☐ Other _____ (Check all that apply)			☐
4. In what year was the dwelling's roof covering installed? _____ (Approximate if no records are available) Explain if necessary: _____			☐
5. Is there any leakage or other problem with the dwelling's roof?	☐	☐	☐
6. Is there any water seepage, leakage, dampness or standing water in the dwelling's basement, crawl space, or slab?	☐	☐	☐
7. Is there any problem, malfunction or defect with the dwelling's electrical system (outlets, wiring, panel, switches, fixtures, generator, etc.)?	☐	☐	☐
8. Is there any problem, malfunction or defect with the dwelling's plumbing system (pipes, fixtures, water heater, etc.)?	☐	☐	☐
9. Is there any problem, malfunction or defect with the dwelling's heating and/or air conditioning?	☐	☐	☐
10. What is the dwelling's heat source? ☐ Furnace ☐ Heat Pump ☐ Baseboard ☐ Other _____ (Check all that apply) Age of system: _____			☐
11. What is the dwelling's cooling source? ☐ Central Forced Air ☐ Wall/Window Unit(s) ☐ Other _____ _____ (Check all that apply) Age of system: _____			☐
12. What are the dwelling's fuel sources? ☐ Electricity ☐ Natural Gas ☐ Propane ☐ Oil ☐ Other _____ _____ (Check all that apply) If the fuel source is stored in a tank, identify whether the tank is ☐ above ground or ☐ below ground, and whether the tank is ☐ leased by seller or ☐ owned by seller. (Check all that apply)			☐
13. What is the dwelling's water supply source? ☐ City/County ☐ Community System ☐ Private Well ☐ Shared Well ☐ Other _____ (Check all that apply)			☐
14. The dwelling's water pipes are made of what type of material? ☐ Copper ☐ Galvanized ☐ Plastic ☐ Polybutylene ☐ Other _____ (Check all that apply)			☐
15. Is there any problem, malfunction or defect with the dwelling's water supply (including water quality, quantity, or water pressure)?	☐	☐	☐
16. What is the dwelling's sewage disposal system? ☐ Septic Tank ☐ Septic Tank with Pump ☐ Community System ☐ Connected to City/County System ☐ City/County System available ☐ Straight pipe (wastewater does not go into a septic or other sewer system [note: use of this type of system violates state law]) ☐ Other _____ (Check all that apply)			☐
17. If the dwelling is serviced by a septic system, do you know how many bedrooms are allowed by the septic system permit? If your answer is "yes," how many bedrooms are allowed? _____ ☐ No records available	☐	☐	☐
18. Is there any problem, malfunction or defect with the dwelling's sewer and/or septic system?	☐	☐	☐
19. Is there any problem, malfunction or defect with the dwelling's central vacuum, pool, hot tub, spa, attic fan, exhaust fan, ceiling fans, sump pump, irrigation system, TV cable wiring or satellite dish, garage door openers, gas logs, or other systems?	☐	☐	☐
20. Is there any problem, malfunction or defect with any appliances that may be included in the conveyance (range/oven, attached microwave, hood/fan, dishwasher, disposal, etc.)?	☐	☐	☐

Buyer Initials and Date _____ Owner Initials and Date _____

Buyer Initials and Date _____ Owner Initials and Date _____

	Yes	No	No Representation
21. Is there any problem with present infestation of the dwelling, or damage from past infestation of wood destroying insects or organisms which has not been repaired?	☐	☐	☐
22. Is there any problem, malfunction or defect with the drainage, grading or soil stability of the property?	☐	☐	☐
23. Are there any structural additions or other structural or mechanical changes to the dwelling(s) to be conveyed with the property?	☐	☐	☐
24. Is the property to be conveyed in violation of any local zoning ordinances, restrictive covenants, or other land-use restrictions, or building codes (including the failure to obtain proper permits for room additions or other changes/improvements)?	☐	☐	☐
25. Are there any hazardous or toxic substances, materials, or products (such as asbestos, formaldehyde, radon gas, methane gas, lead-based paint) which exceed government safety standards, any debris (whether buried or covered) or underground storage tanks, or any environmentally hazardous conditions (such as contaminated soil or water, or other environmental contamination) which affect the property?	☐	☐	☐
26. Is there any noise, odor, smoke, etc. from commercial, industrial, or military sources which affects the property?	☐	☐	☐
27. Is the property subject to any utility or other easements, shared driveways, party walls or encroachments from or on adjacent property?	☐	☐	☐
28. Is the property the subject of any lawsuits, foreclosures, bankruptcy, leases or rental agreements, judgments, tax liens, proposed assessments, mechanics' liens, materialmens' liens, or notices from any governmental agency that could affect title to the property?	☐	☐	☐
29. Is the property subject to a flood hazard or is the property located in a federally-designated flood hazard area?	☐	☐	☐
30. Does the property abut or adjoin any private road(s) or street(s)?	☐	☐	☐
31. If there is a private road or street adjoining the property, is there in existence any owners' association or maintenance agreements dealing with the maintenance of the road or street?	☐	☐	☐

If you answered "yes" to any of the questions listed above (1-31) please explain (attach additional sheets if necessary):

_____

_____

In lieu of providing a written explanation, you may attach a written report to this Disclosure Statement by a public agency, or by an attorney, engineer, land surveyor, geologist, pest control operator, contractor, home inspector, or other expert, dealing with matters within the scope of that public agency's functions or the expert's license or expertise.

The following questions pertain to the property identified above, including the lot to be conveyed and any dwelling unit(s), sheds, detached garages, or other buildings located thereon.

	Yes	No	No Representation
32. Is the property subject to governing documents which impose various mandatory covenants, conditions, and restrictions upon the lot or unit?	☐	☐	☐
If you answered "yes" to the question above, please explain (attach additional sheets if necessary): _____ _____			
33. Is the property subject to regulation by one or more owners' association(s) including, but not limited to, obligations to pay regular assessments or dues and special assessments? If you answer is "yes," please provide the information requested below as to each owners' association to which the property is subject [insert N/A into any blank that does not apply]:	☐	☐	☐
• (specify name) _____ whose regular assessments ("dues") are $ _____ per _____. The name, address and telephone number of the president of the owners' association or the association manager are _____ _____ _____			
• (specify name) _____ whose regular assessments ("dues") are $ _____ per _____. The name, address and telephone number of the president of the owners' association or the association manager are _____ _____ _____			

Buyer Initials and Date _____ Owner Initials and Date _____

Buyer Initials and Date _____ Owner Initials and Date _____

***If you answered "Yes" to question 33 above, you must complete the remainder of this Disclosure Statement. If you answered "No" or "No Representation" to question 33 above, you do not need to answer the remaining questions on this Disclosure Statement. Skip to the bottom of the last page and initial and date the page.**

	Yes	No	No Representation
34. Are any fees charged by the association or by the association's management company in connection with the conveyance or transfer of the lot or property to a new owner? If your answer is "yes," please state the amount of the fees: _____	☐	☐	☐
35. As of the date this Disclosure Statement is signed, are there any dues, fees, or special assessments which have been duly approved as required by the applicable declaration or bylaws, and that are payable to an association to which the lot is subject? If your answer is "yes," please state the nature and amount of the dues, fees, or special assessments to which the property is subject: _____	☐	☐	☐
36. As of the date this Disclosure Statement is signed, are there any unsatisfied judgments against, or pending lawsuits *involving the property or lot to be conveyed*? If your answer is "yes," please state the nature of each pending lawsuit, and the amount of each unsatisfied judgment: _____	☐	☐	☐
37. As of the date this Disclosure Statement is signed, are there any unsatisfied judgments against, or pending lawsuits *involving the planned community or the association to which the property and lot are subject*, with the exception of any action filed by the association for the collection of delinquent assessments on lots other than the property and lot to be conveyed? If your answer is "yes," please state the nature of each pending lawsuit, and the amount of each unsatisfied judgment: _____	☐	☐	☐

38. Which of the following services and amenities are paid for by the owners' association(s) identified above out of the association's regular assessments ("dues")? (Check all that apply).

	Yes	No	No Representation
Management Fees	☐	☐	☐
Exterior Building Maintenance of Property to be Conveyed	☐	☐	☐
Master Insurance	☐	☐	☐
Exterior Yard/Landscaping Maintenance of Lot to be Conveyed	☐	☐	☐
Common Areas Maintenance	☐	☐	☐
Trash Removal	☐	☐	☐
Recreational Amenity Maintenance (specify amenities covered) _____	☐	☐	☐
Pest Treatment/Extermination	☐	☐	☐
Street Lights	☐	☐	☐
Water	☐	☐	☐
Sewer	☐	☐	☐
Storm water Management/Drainage/Ponds	☐	☐	☐
Internet Service	☐	☐	☐
Cable	☐	☐	☐
Private Road Maintenance	☐	☐	☐
Parking Area Maintenance	☐	☐	☐
Gate and/or Security	☐	☐	☐

Other: (specify) _____

Buyer Initials and Date _____ Owner Initials and Date _____

Buyer Initials and Date _____ Owner Initials and Date _____

REC 4.22
REV 7/18

SELLER'S DISCLOSURE OF REAL PROPERTY CONDITION REPORT
State of Delaware
Approved by the Delaware Real Estate Commission 5/11/17 (effective 10/1/17)

Seller(s) Name: _____

Property Address: _____

Approximate Age of Building(s): _____ **Date Purchased:** _____

Chapter 25, Title 6 of the Delaware Code, requires a Seller of residential property to disclose in writing all material defects of the property that are known at the time the property is offered for sale or that are known prior to the time of final settlement. Residential property means any interest in a property or manufactured housing lot, improved by dwelling units for 1-4 families. The disclosure must be made on this Report, which has been approved by the Delaware Real Estate Commission, and shall be updated as necessary for any material changes occurring in the property before final settlement. This Report shall be given to all prospective Buyers prior to the time the Buyer makes an offer to purchase. This Report, signed by Buyer and Seller, shall become a part of the Agreement of Sale. This Report is a good faith effort by the Seller to make the disclosures required by Delaware law and is not a warranty of any kind by the Seller or any Agents or Sub-Agents representing Seller or Buyer in the transfer and is not a substitute for any inspections or warranties that the Seller or Buyer may wish to obtain. The Buyer has no cause of action against the Seller or Real Estate Agent for material defects in the property disclosed to the Buyer prior to the Buyer making an offer; material defects developed after the offer was made but disclosed in an update of this Report prior to settlement, provided Seller has complied with the Agreement of Sale; or material defects which occur after settlement. State websites containing helpful information include: Office of State Planning Coordination www.stateplanning.delaware.gov, Delaware Department of Natural Resources and Environmental Control dnrec.alpha.delaware.gov, Delaware Division of Public Health www.dhss.delaware.gov/dhss/dph, Delaware State Police Sex Offender Registry www.sexoffender.dsp.delaware.gov and other agencies listed on www.delaware.gov.

Yes	No	*	*** Write in *U* if Unknown or *NA* if Not Applicable, otherwise mark either the Yes or No column. Where selections are requested, place a check mark next to each correct answer or fill in the correct answer. Certain answers require a further explanation in Section XVI.**
			I. OCCUPANCY
			1. Do you currently occupy this property full-time? If No, how long has it been since you occupied the property? _____. Property is your: (____Primary Residence) (____ Second / Vacation Home) (___ Rental Property) (___ Inherited Property) (____Other_____).
			2. Is the property encumbered by a (___lease), (___option to purchase), or (___first right of refusal)? If Yes, describe in XVI.
			3. If the property is leased, have all necessary permits / licenses been obtained?
			4. Is the property new construction?
			5. If #4 is Yes, Seller warrants that the property (___ is) or (___ is not) exempt from providing the buyer with a **Public Offering Statement** as described in §81-401 or §81-403(b) of Chapter 81, Title 25 of the Delaware Code, The Delaware Uniform Common Interest Ownership Act. If not exempt, in compliance with §317A of Chapter 3, Title 25, Seller has attached a copy of all documents in the chain of title that create any financial obligation for the buyer, and a written summary of all financial obligations created by documents in the chain of title. As evidenced by signature below, buyer has received a copy of these documents.

Seller's Initials _____ Seller's Initials_____ Buyer's Initials_____ Buyer's Initials _____

Seller's Initials _____ Seller's Initials_____ Buyer's Initials_____ Buyer's Initials _____

Yes	No	*	* **Write in *U* if Unknown or *NA* if Not Applicable, otherwise mark either the Yes or No column. Where selections are requested, place a check mark next to each correct answer or fill in the correct answer. Certain answers require a further explanation in Section XVI.**
			II. <u>DEED RESTRICTIONS, HOMEOWNERS ASSOCIATIONS / CONDOMINIUMS AND CO-OPS</u>
			6. Is the property subject to any deed restrictions? If Yes, describe in XVI.
			7. Are you in violation of any deed restrictions at this time? If Yes, describe in XVI.
			8. Is the property subject to any agreements concerning affordable housing or workforce housing?
			9. Is the property subject to any private or public architectural review control other than building codes?
			10. Is the property part of a condominium or other common ownership?
			11. Is there a (___Homeowners Association), (___Condominium Association), (___Civic Association), or (___Maintenance Corporation) included in the deed?
			12. Is there a capital contribution fee due by a new owner to the Association? If yes, how much _____?
			13. If #11 is Yes, are there any (___ fees), (___ dues), (___assessments), or (___bonds) involved? If Yes, how much? _____and how often? _____. Are they (___ Mandatory) or (___Voluntary)?
			14. Are there any unpaid assessments? If Yes, indicate amount _____. If Yes, describe in XVI.
			15. Has there been a special assessment in the past 12 months? If Yes, describe in XVI.
			16. Have you received notice of any new or proposed increases in fees, dues, assessments, or bonds? If Yes, describe in XVI.
			17. Is there any condition or claim which may result in an increase in assessments or fees? If Yes, describe in XVI.
			18. Management Company Name: _____
			19. Representative Name: _____ Phone # _____
			20. Representative E-mail Address: _____
			III. <u>TITLE / ZONING INFORMATION</u>
			21. Does the amount owed on your mortgages and other liens exceed the estimated value of the property? If Yes, are additional funds available from Seller for settlement? _____
			22. Is your property owned (___ In fee simple) or (___ Leasehold) or (___Cooperative)?
			23. Are there any right-of-ways, easements, or similar matters that may affect the property? If Yes, describe in XVI.
			24. Are there any shared maintenance agreements affecting the property? If Yes, describe in XVI.
			25. Are there any variance, zoning, non-conforming use, or setback violations? If Yes, describe in XVI.
			26. Has the variance or non-conforming use expired or would not be transferable? If Yes, describe in XVI.
			27. Has a title policy been issued on the property in the past 5 years?
			IV. <u>MISCELLANEOUS</u>
			28. Have you received notice from any local, state, or federal agencies requiring repairs, alterations, or corrections of any existing conditions? If Yes, describe in XVI.
			29. Is there any existing or threatened legal action affecting this property? If Yes, describe in XVI.
			30. Are there any violations of local, state, federal laws, or regulations relating to this property? If Yes, describe in XVI.
			31. Does your current real estate tax amount reflect any non-transferrable exemptions – discounts?
			32. Is there anything else you should disclose to a prospective Buyer because it may materially and adversely affect the property, e.g., zoning changes, road changes, proposed utility changes, threat of condemnation, noise, bright lights, odors, or other nuisances, etc.? If Yes to any, describe in XVI.
			33. Are all the exterior door locks in the house in working condition? If No, describe in XVI.
			34. Will keys be provided for each lock?
			35. Have you had, or do you now have, any animals (pets) in the house? If yes, what type?_____
			36. Is there or has there ever been a (___swimming pool), (___hot tub), (___spa), or (___whirlpool) on the property? If Yes and there are any defects describe in XVI.
			37. If there is a pool, does it conform to all local ordinances? If No, describe in XVI.
			38. What is the type of trash disposal? (___Private), (___ Municipal) or (___ Other _____).

Yes	No	*	* **Write in *U* if Unknown or *NA* if Not Applicable, otherwise mark either the Yes or No column. Where selections are requested, place a check mark next to each correct answer or fill in the correct answer. Certain answers require a further explanation in Section XVI.**
			39. The cost of repairing and paving the streets adjacent to the property is paid for by:
			_____ The property owner(s), estimated fees: $ _____
			_____ Delaware Department of Transportation or the State of Delaware
			_____ City or Town
			_____Other
			_____ Unknown
			Note to Buyer: Repairing and repaving of the streets can be very costly. **(6 Delaware Code§ 2578)**
			40. Is off street parking available for this property? If Yes, number of spaces available: _____
			V. ENVIRONMENTAL HAZARDS
			41. Are there now or have there been any underground storage tanks on the property? For (___heating fuel), (___propane), (___septic), or (___Other _____). If Yes, describe locations in XVI.
			42. If the tank was abandoned, was it done with all necessary permits and properly abandoned?
			43. Are asbestos-containing materials present? If Yes, describe in XVI.
			44. Are there any lead hazards? (e.g., lead paint, lead pipes, lead in soil.) If Yes, describe in XVI.
			45. Has the property been tested for toxic or hazardous substances? Attach each test report, if available.
			46. Has the property ever been tested for mold, if Yes, provide the test results.
			47. Is there currently mold in the property? If Yes, describe in XVI.
			48. Has the illegal manufacture, storage, or use of methamphetamines occurred in the property? If Yes, describe in XVI.
			VI. LAND (SOILS, DRAINAGE, AND BOUNDARIES)
			49. Is there fill soil or other fill material on the property?
			50. Are there any sliding, settling, earth movement, upheaval, earth stability, or methane gas release problems that have occurred on the property or in the immediate neighborhood? If Yes, describe in XVI.
			51. Is any part of the property located in (____ a flood zone) and / or (____ a wetlands area)?
			52. Are there any drainage or flood problems affecting the property? If Yes, describe in XVI.
			53. Do you carry flood insurance? Agent: _____ Policy # _____
			54. If # 53 is Yes, what is the annual cost of this policy? _____
			55. Have you made any insurance claims on the property in the past 5 years? If Yes, describe in XVI.
			56. Does the property have standing water in front, rear, or side yards for more than 48 hours after raining?
			57. Are there encroachments or boundary line disputes affecting the property? If Yes, describe in XVI.
			58. Are there any tax ditches crossing or bordering the property?
			59. Are there any swales crossing the property that are under the control of a Soil and Conservation District? If Yes, describe in XVI.
			60. Has the property ever been surveyed?
			61. Are the boundaries of the property marked in any way?
			VII. STRUCTURAL ITEMS
			62. Have you made any additions or structural changes? If Yes, describe in XVI.
			63. If Yes, was all work done with all necessary permits and approvals in compliance with building codes?
			64. Is there any movement, shifting, or other problems with walls or foundations? If Yes, describe in XVI.
			65. Have the property or improvements thereon, ever been damaged by (___fire), (___smoke), (___wind), or (___flood)? If Yes, describe in XVI.
			66. Was the structure moved to this site? (___ Double Wide) (___ Modular) (___Other: _____)
			67. Is there any (___ past) or (___present) water leakage in the house? If Yes, describe in XVI.
			68. Are there any problems with (___driveways), (___walkways), (___ patios), or (___ retaining walls) on the property? If Yes, describe in XVI.
			69. Have there been any repairs or other attempts to control the cause or effect of problems described in questions 67 and 68? If Yes, describe in XVI.
			70. Is there insulation in:
			The ceiling / attic?
			The exterior walls?
			Other places? Describe _____

Yes	No	*	* **Write in *U* if Unknown or *NA* if Not Applicable, otherwise mark either the Yes or No column. Where selections are requested, place a check mark next to each correct answer or fill in the correct answer. Certain answers require a further explanation in Section XVI.**
			What type(s) of insulation does your property have? _____
			71. Are there any drywall issues or drywall smells? If Yes, describe in XVI.
			VIII. TERMITES, DRYROT, PESTS
			72. Is there, or has there been, any infestation by termites or other wood destroying insects? If Yes, describe in XVI.
			73. Is there or has there been any damage to the property caused by (___ termites), (___other wood destroying insects), (___pests), or (___dry rot)? If Yes, describe in XVI.
			74. Has there been any termite or other wood destroying insect inspections made on the property subsequent to your purchase? If Yes, describe in XVI.
			75. Has there been any pest control inspections made on the property subsequent to your purchase. If Yes, describe in XVI.
			76. Has there been any termite or wood destroying insect treatments made on the property? If Yes, describe in XVI.
			77. Has there been any pest control treatments made on the property? If Yes, describe in XVI.
			78. Is your property currently under warranty, or other coverage, by a professional pest control company? If Yes, name of exterminating company: _____
			IX. BASEMENT AND CRAWL SPACES
			79. Does the property have a sump pump? If Yes, where does it drain? _____
			80. Is there any water leakage, accumulation, or dampness within the basement or crawlspace?
			81. Has there been any repairs or other attempts to control any water or dampness problem in the basement or crawlspace? If Yes, describe in XVI.
			82. Are there any cracks or bulges in the floor or foundation walls? If Yes, describe in XVI.
			X. ROOF
			83. Date last roof surface installed: _____
			84. How many layers of roof material are there (e.g., new shingles over old shingles)? _____
			85. Are there any problems with the roof, flashing, or rain gutters? If Yes or repaired under your ownership, explain in XVI.
			86. If under warranty, is warranty transferable?
			87. Where do your gutters drain? (___ Surface) (___ Drywell) (___ Storm Sewers) (___Other _____)
			XI. PLUMBING-RELATED ITEMS
			88. What is the drinking water source? _____.
			89. If drinking water supplied by utility, name of utility: _____.
			90. What type of plumbing (copper, lead, cast iron, PVC, polybutylene, galvanized, unknown) is in the house? 1. Water supply _____ 2. Drainage _____
			91. Have there been any additions / upgrades to the original service? If Yes, describe in XVI.
			92. If any, was the work done by a licensed contractor?
			93. If Yes to above, were the required permits obtained?
			94. If your drinking water is from a well, when was your water last tested and what were the results of the test? Tested on: _____, Results: _____.
			95. When was well installed? _____Location of well? _____ Depth of well? _____
			96. Is there a water treatment system? If Yes, (___ Leased) or (___ Owned)?
			97. What is the type of sewage system? (___ Public Sewer) (___Community Sewer) (___ Septic System) (___ Cesspool) (___Other _____)
			98. If a septic system, type: (___ Gravity Fed) (___ Capping Fill) (___ LPP) (___ Mound) (____ Holding Tank) (____ Other:_____)
			99. Has the septic system been pumped out by a Class F contractor and inspected by a Class H inspector within the past 36 months?
			100. Is there a wastewater spray irrigation system installed on or adjacent to the property?
			101. Has a soil / site evaluation ever been done? If Yes, when? _____ Results? _____
			102. Any leaks, backups, or other problems relating to any of the plumbing, water, and sewage related items? If Yes, describe in XVI.

Yes	No	*	* **Write in *U* if Unknown or *NA* if Not Applicable, otherwise mark either the Yes or No column. Where selections are requested, place a check mark next to each correct answer or fill in the correct answer. Certain answers require a further explanation in Section XVI.**
			103. Are there any shut off, disconnected, or abandoned wells, underground water, or sewer tanks on the property? If Yes, describe locations in XVI.
			104. If #103 is Yes, were they abandoned with all necessary permits and properly abandoned?
			105. Water heater type: (___ Electric) (___ Oil) (___ Gas) or (___ Other: _____)
			XII. HEATING AND AIR CONDITIONING
			106. How many heating and / or air conditioning zones are in the property? _____. If more than one, indicate the zone number next to each answer in this section and provide the answer for each zone.
			107. What is the type of heating system and fuel? (e.g., System: forced air, heat pump, hot water, baseboard. Fuel: oil, gas, electric, solar etc.) System: _____ Fuel: _____
			108. Age of furnace? _____ Date of last service? _____
			109. Are there any contractual obligations affecting the fuel supply, tanks, or systems? If Yes, describe in XVI.
			110. What is the type of air conditioning system? (e.g., central, window units) _____
			111. Age of air conditioning system? _____ Date of last service? _____
			112. Has there been any additions / upgrades to the original heating or air conditioning? If Yes, describe in XVI.
			113. If question 112 is Yes, was work done by a licensed contractor?
			114. If Yes to the above, were the required permits obtained?
			115. Are there any problems with the heating or air conditioning systems? If Yes, describe in XVI.
			XIII. ELECTRICAL SYSTEM
			116. What type of wiring is in the house? (copper, aluminum, other, etc.) _____
			117. What amp service does it have? (___ 60) (___ 100) (___ 150) (___ 200) (___ Other: _____) Do you have (___ Circuit Breakers) or (___ Fuses) ?
			118. Does it have any 220 / 240-volt circuits?
			119. Do fuses blow or circuit breakers trip when two or more appliances are being used at the same time? If Yes, describe in XVI.
			120. Have there been any additions to the original service?
			121. Have any (___ solar) and / or (___ wind power) enhancements been made to supplement service?
			122. If Yes to questions 120 or 121, was work done by a licensed electrician?
			123. If Yes to the above, were the required permits obtained?
			124. Are there wall switches, light fixtures, or electrical outlets in need of repair? If Yes, explain in XVI.
			125. Are the permits associated with questions 62, 92, 112, and 120 closed?
			XIV. FIREPLACE OR HEATING STOVE
			126. Fireplace Type: (___ Wood Burning) (___ Gas) (___ Insert) (___ Other: _____)?
			127. Heating Stove type: (___ Wood Burning) (___ Pellet) (___ Other _____)?
			128. Was the fireplace or heating stove part of the original house design?
			129. Was the fireplace or heating stove installed by a professional contractor or manufacturer's representative?
			130. Are there any problems? If Yes, explain in XVI.
			131. When were the flues / chimneys last cleaned, serviced or repaired? _____ Explain nature of service or repair in XVI.

XV. MAJOR APPLIANCES AND OTHER ITEMS

(A) Are you aware of any problems affecting the following areas? If Yes, describe in XVI.

	Yes	No	NA		Yes	No	NA
Ceilings				Exterior Walls			
Floors				Interior Walls			
Patios / Decks / Porches				Windows			
				Driveways			
				Outside Walkways			

(B) Are the following included items in working order? Note: The Agreement of Sale will specify and govern what is included or excluded. If an item does not convey or does not exist, leave the yes / no fields blank.

YES	NO		YES	NO		YES	NO	
☐	☐	Range with oven	☐	☐	Draperies/Curtains	☐	☐	Wall Mounted Flat Screen TV #_____
☐	☐	Range Hood-exhaust fan	☐	☐	Drapery/Curtain rods	☐	☐	Wall brackets for TV #_____
☐	☐	Cooktop-stand alone	☐	☐	Shades/Blinds	☐	☐	Surround sound system & controls
☐	☐	Wall Oven(s) #_____	☐	☐	Cornices/Valances	☐	☐	Solar Equipment
☐	☐	Kitchen Refrigerator	☐	☐	Furnace Humidifier	☐	☐	Attached Antenna/Rotor
☐	☐	with icemaker	☐	☐	Smoke Detectors	☐	☐	Garage Opener(s) #_____
☐	☐	Refrigerator(s)-additional #_____	☐	☐	Carbon Monoxide Detectors	☐	☐	with remote(s) #_____
☐	☐	Freezer –free standing	☐	☐	Wood Stove	☐	☐	Pool Equipment
☐	☐	Ice Maker-free standing	☐	☐	Fireplace Equipment	☐	☐	Pool cover
☐	☐	Dishwasher	☐	☐	Fireplace Screen/Doors	☐	☐	Hot Tub, Equipment
☐	☐	Disposal	☐	☐	Electronic Air Filter	☐	☐	with cover
☐	☐	Microwave	☐	☐	Window A/C Units #_____	☐	☐	Sheds/Outbuildings #_____
☐	☐	Washer	☐	☐	Attic fan	☐	☐	Playground Equipment
☐	☐	Dryer	☐	☐	Whole house fan	☐	☐	Irrigation System
☐	☐	Trash Compactor	☐	☐	Bathroom Vents/Fans	☐	☐	Water Conditioner (owned)
☐	☐	Water Filter	☐	☐	Window Fan(s) #_____	☐	☐	Water Conditioner (leased)
☐	☐	Water Heater	☐	☐	Ceiling Fan(s) #_____	☐	☐	Fuel Storage Tank(s) (owned)
☐	☐	Sump Pump	☐	☐	Central Vacuum	☐	☐	Fuel Storage Tank(s) (leased)
☐	☐	Storm Doors	☐	☐	with attachments	☐	☐	Security/Monitoring Systems (owned)
☐	☐	Screens (where present)	☐	☐	Intercoms	☐	☐	Security/Monitoring Systems (leased)
			☐	☐	Satellite Dish	☐	☐	Solar Equipment (owned)
			☐	☐	with controls & Remote(s)	☐	☐	Solar Equipment (leased)

XVI. ADDITIONAL INFORMATION

If you were directed to this section to clarify an answer, or if you indicated there is a problem with any of the items in sections I through XV, provide a detailed explanation below, or on additional sheet(s). Attach additional sheets if needed.

Question Number	Additional Information

Are there additional problems, clarification, or document sheets attached? ☐ No ☐ Yes
Number of Sheets Attached _____.

ACKNOWLEDGMENT OF SELLER

Seller has provided the information contained in this report. This information is to the best of Seller's knowledge and belief is complete, true, and accurate. Seller has no knowledge, information, or other reason to believe that any defects or problems with the property have been disclosed to, or discussed with, any Real Estate Agent or Broker involved in the sale of this property, other than those set forth in this report. Seller does hereby indemnify and hold harmless any Real Estate Agent involved in the sale of this property from any liability incurred as a result of any third-party reliance on the disclosures contained herein, or on any subsequent amendment hereto. Seller's Broker and / or Cooperating Broker, if any, is / are hereby authorized to furnish this report to any prospective Buyer. This is a legally binding document. If not understood, an attorney should be consulted.

SELLER _____Date_____SELLER _____ Date_____

SELLER _____Date_____SELLER _____ Date_____

Date the contents of this Report were last updated: _____

ACKNOWLEDGMENT OF BUYER

Buyer is relying upon the above report, and statements within the Agreement of Sale, as the representation of the condition of property, and is not relying upon any other information about the property. Buyer has carefully inspected the property and Buyer acknowledges that Agents are not experts at detecting or repairing physical defects in property. Buyer understands there may be areas of the property of which Seller has no knowledge and this report does not encompass those areas. Unless stated otherwise in my contract with Seller, the property is real estate being sold in its present condition, without warranties or guarantees of any kind by Seller or any Agent. Buyer has received and read a signed copy of this report. Buyer may negotiate in the Agreement of Sale for other professional advice and / or inspections of the property. Buyer understands there may be projects either planned or being undertaken by the State, County, or Local Municipality which may affect this property of which the Seller has no knowledge. Buyer further understands that it is Buyer's responsibility to contact the appropriate agencies to determine whether any such projects are planned or underway. If Buyer does not understand the impact of such project(s) on the property being purchased, Buyer should consult with an Attorney. Buyer understands that before signing an Agreement of Sale, Buyer may review the applicable Master Plan or Comprehensive Land Use Plan for the County and / or appropriate City or Town Plans showing planned land uses, zoning, roads, highways, locations, and nature of current or proposed parks and other public facilities. This is a legally binding document. If not understood, an attorney should be consulted.

BUYER _____ Date_____ BUYER _____ Date_____

BUYER _____ Date_____ BUYER _____ Date_____

Seller's Property Disclosure – Residential

FloridaRealtors®

Notice to Licensee and seller: Only the **Seller** should fill out this form.

Notice to Seller: Florida law[1] requires a **Seller** of a home to disclose to the **Buyer** all known facts that materially affect the value of the property being sold and that are not readily observable or known by the **Buyer**. This disclosure form is designed to help you comply with the law. However, this disclosure form may not address every significant issue that is unique to the Property. You should think about what you would want to know if you were buying the Property today; and if you need more space for additional information, comments, or explanations, check the Paragraph 12 checkbox and attach an addendum.

Notice to Buyer: The following representations are made by **Seller** and **not** by any real estate licensee. This disclosure is not a guaranty or warranty of any kind. It is not a substitute for any inspections, warranties, or professional advice you may wish to obtain. It is not a substitute for your own personal judgment and common sense. The following information is based only upon **Seller's** actual knowledge of the Property's condition. **Sellers** can disclose only what they actually know. **Seller** may not know about all material or significant items. You should have an independent, professional home inspection to verify the condition of the Property and determine the cost of repairs, if any. This disclosure is not a contract and is not intended to be a part of any contract for sale and purchase.

Seller makes the following disclosure regarding the property described as: _____

_____ (the "Property")

The Property is ☐owner occupied ☐tenant occupied ☐unoccupied (If unoccupied, how long has it been since **Seller** occupied the Property? _____

	Yes	No	Don't Know
1. Structures; Systems; Appliances			
(a) Are the structures including ceilings; walls; doors; windows; foundation; and pool, hot tub, and spa, if any, structurally sound and free of leaks?	☐	☐	☐
(b) Is seawall, if any, and dockage, if any, structurally sound?	☐	☐	☐
(c) Are existing major appliances and heating, cooling, mechanical, electrical, security, and sprinkler systems, in working condition, i.e., operating in the manner in which the item was designed to operate?	☐	☐	☐
(d) Does the Property have aluminum wiring other than the primary service line?	☐	☐	☐
(e) Are any of the appliances leased? If yes, which ones: _____	☐	☐	☐
(f) If any answer to questions 1(a) - 1(c) is no, please explain: _____			
_____			
2. Termites; Other Wood-Destroying Organisms; Pests			
(a) Are termites; other wood-destroying organisms, including fungi; or pests present on the Property or has the Property had any structural damage by them?	☐	☐	☐
(b) Has the Property been treated for termites; other wood-destroying organisms, including fungi; or pests?	☐	☐	☐
(c) If any answer to questions 2(a) - 2(b) is yes, please explain: _____			
_____			
3. Water Intrusion; Drainage; Flooding			
(a) Has past or present water intrusion affected the Property?	☐	☐	☐
(b) Have past or present drainage or flooding problems affected the Property?	☐	☐	☐
(c) Is any of the Property located in a special flood hazard area?	☐	☐	☐
(d) Is any of the Property located seaward of the coastal construction control line?	☐	☐	☐
(e) Does your lender require flood insurance?	☐	☐	☐
(f) Do you have an elevation certificate? If yes, please attach a copy.	☐	☐	☐
(g) If any answer to questions 3(a) - 3(d) is yes, please explain: _____			
_____			

[1] *Johnson v. Davis*, 480 So.2d 625 (Fla. 1985).

Seller (_____) (_____) and **Buyer** (_____) (_____) acknowledge receipt of a copy of this page, which is Page 1 of 5.

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formsimplicity

	Yes	No	Don't Know
4. Plumbing			
(a) What is your drinking water source? ☐ public ☐ private ☐ well ☐ other			
(b) Have you ever had a problem with the quality, supply, or flow of potable water?	☐	☐	☐
(c) Do you have a water treatment system? If yes, is it ☐ owned ☐ leased?	☐	☐	☐
(d) Do you have a ☐ sewer or ☐ septic system? If septic system, describe the location of each system: _____			
(e) Are any septic tanks, drain fields, or wells that are not currently being used located on the Property?	☐	☐	☐
(f) Have there been any plumbing leaks since you have owned the Property?	☐	☐	☐
(g) Are any polybutylene pipes on the Property?	☐	☐	☐
(h) If any answer to questions 4(b), 4(c), and 4(e) - 4(g) is yes, please explain: _____			
5. Roof and Roof-Related Items			
(a) To your knowledge, is the roof structurally sound and free of leaks?	☐	☐	☐
(b) The age of the roof is _____ years OR date installed _____			
(c) Has the roof ever leaked during your ownership?	☐	☐	☐
(d) To your knowledge, has there been any repair, restoration, replacement (indicate full or partial) or other work undertaken on the roof? If yes, please explain: _____	☐	☐	☐
(e) Are you aware of any defects to the roof, fascia, soffits, flashings or any other component of the roof system? If yes, please explain: _____	☐	☐	☐
6. Pools; Hot Tubs; Spas **Note:** Florida law requires swimming pools, hot tubs, and spas that received a certificate of completion on or after October 1, 2000, to have at least one safety feature as specified by Section 515.27, Florida Statutes.			
(a) If the Property has a swimming pool, hot tub, or spa that received a certificate of completion on or after October 1, 2000, indicate the existing safety feature(s): ☐ enclosure that meets the pool barrier requirements ☐ approved safety pool cover ☐ required door and window exit alarms ☐ required door locks ☐ none			
(b) Has an in-ground pool on the Property been demolished and/or filled?	☐	☐	☐
7. Sinkholes **Note:** When an insurance claim for sinkhole damage has been made by the **Seller** and paid by the insurer, Section 627.7073(2)(c), Florida Statutes, requires the **Seller** to disclose to the **Buyer** that a claim was paid and whether or not the full amount paid was used to repair the sinkhole damage.			
(a) Does past or present settling, soil movement, or sinkhole(s) affect the Property or adjacent properties?	☐	☐	☐
(b) Has any insurance claim for sinkhole damage been made? If yes, was the claim paid? ☐ yes ☐ no If the claim was paid, were all the proceeds used to repair the damage? ☐ yes ☐ no	☐	☐	☐
(c) If any answer to questions 7(a) - 7(b) is yes, please explain: _____			

Seller (_____) (_____) and **Buyer** (_____) (_____) acknowledge receipt of a copy of this page, which is Page 2 of 5.

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	Yes	No	Don't Know
8. Homeowners' Association Restrictions; Boundaries; Access Roads			
(a) Is membership in a homeowner's association mandatory or do any covenants, conditions or restrictions (CCRs) affect the Property? (CCRs include deed restrictions, restrictive covenants and declaration of covenants.) **Notice to Buyer:** If yes, you should read the association's official records and/or the CCRs before making an offer to purchase. These documents contain information on significant matters, such as recurring dues or fees; special assessments; capital contributions, penalties; and architectural, building, landscaping, leasing, parking, pet, resale, vehicle and other types of restrictions.	☐	☐	☐
(b) Are there any proposed changes to any of the restrictions?	☐	☐	☐
(c) Are any driveways, walls, fences, or other features shared with adjoining landowners?	☐	☐	☐
(d) Are there any encroachments on the Property or any encroachments by the Property's improvements on other lands?	☐	☐	☐
(e) Are there boundary line disputes or easements affecting the Property?	☐	☐	☐
(f) Are you aware of any existing, pending or proposed legal or administrative action affecting homeowner's association common areas (such as clubhouse, pools, tennis courts or other areas)?	☐	☐	☐
(g) Have any subsurface rights, as defined by Section 689.29(3)(b), Florida Statutes, been severed from the Property? If yes, is there a right of entry? ☐ yes ☐ no	☐	☐	☐
(h) Are access roads ☐ private ☐ public? If private, describe the terms and conditions of the maintenance agreement: _____ _____			
(i) If any answer to questions 8(a) - 8(g) is yes, please explain: _____ _____			
9. Environmental			
(a) Was the Property built before 1978? If yes, please see Lead-Based Paint Disclosure.	☐	☐	☐
(b) Does anything exist on the Property that may be considered an environmental hazard, including but not limited to, lead-based paint; asbestos; mold; urea formaldehyde; radon gas; methamphetamine contamination; defective drywall; fuel, propane, or chemical storage tanks (active or abandoned); or contaminated soil or water?	☐	☐	☐
(c) Has there been any damage, clean up, or repair to the Property due to any of the substances or materials listed in subsection (b) above?	☐	☐	☐
(d) Are any mangroves, archeological sites, or other environmentally sensitive areas located on the Property?	☐	☐	☐
(e) If any answer to questions 9(b) - 9(d) is yes, please explain: _____ _____			
10. Governmental, Claims and Litigation			
(a) Are there any existing, pending or proposed legal or administrative claims affecting the Property?	☐	☐	☐
(b) Are you aware of any existing or proposed municipal or county special assessments affecting the Property?	☐	☐	☐
(c) Are you aware of the Property ever having been, or is it currently, subject to litigation or claim, including but not limited to, defective building products, construction defects and/or title problems?	☐	☐	☐
(d) Have you ever had any claims filed against your homeowner's Insurance policy?	☐	☐	☐
(e) Are there any zoning violations or nonconforming uses?	☐	☐	☐

Seller (_____) (_____) and **Buyer** (_____) (_____) acknowledge receipt of a copy of this page, which is Page 3 of 5.

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(f) Are there any zoning restrictions affecting improvements or replacement of the Property?	☐	☐	☐
(g) Do any zoning, land use or administrative regulations conflict with the existing use of the Property?	☐	☐	☐
(h) Do any restrictions other than association or flood area requirements, affect improvements or replacement of the Property?	☐	☐	☐
(i) Are any improvements, located below the base flood elevation?	☐	☐	☐
(j) Have any improvements been constructed in violation of applicable local flood guidelines?	☐	☐	☐
(k) Have any improvements to the Property, whether by you or by others, been constructed in violation of building codes or without necessary permits?	☐	☐	☐
(l) Are there any active permits on the Property that have not been closed by a final inspection?	☐	☐	☐
(m) Is there any violation or non-compliance regarding any unrecorded liens; code enforcement violations; or governmental, building, environmental and safety codes, restrictions or requirements?	☐	☐	☐

(n) If any answer to questions 10(a) - 10(m) is yes, please explain: _____

_____

11. Foreign Investment in Real Property Tax Act ("FIRPTA")

(a) Is the **Seller** subject to FIRPTA withholding per Section 1445 of the Internal Revenue Code? **If yes, Buyer and Seller should seek legal and tax advice regarding compliance.**	☐	☐	☐

12. ☐ **(If checked) Other Matters; Additional Comments** The attached addendum contains additional information, explanation, or comments.

Seller represents that the information provided on this form and any attachments is accurate and complete to the best of **Seller's** knowledge on the date signed by **Seller**. **Seller** authorizes listing broker to provide this disclosure statement to real estate licensees and prospective **buyers** of the Property. **Seller** understands and agrees that **Seller** will promptly notify **Buyer** in writing if any information set forth in this disclosure statement becomes inaccurate or incorrect.

Seller: _____ / _____ Date: _____
(signature) (print)

Seller: _____ / _____ Date: _____
(signature) (print)

Buyer acknowledges that **Buyer** has read, understands, and has received a copy of this disclosure statement.

Buyer: _____ / _____ Date: _____
(signature) (print)

Buyer: _____ / _____ Date: _____
(signature) (print)

Seller's Update

Instructions to Seller: If the information set forth in this disclosure statement becomes inaccurate or incorrect, you must promptly notify **Buyer**. Please review the questions and your answers. Use the space below to make corrections and provide additional information, if necessary. Then acknowledge that the information is accurate as of date signed below.

Seller represents that the information provided on this form and any attachments is accurate and complete to the best of **Seller's** knowledge on the date signed by **Seller**.

Seller: _____ / _____ Date: _____
(signature) (print)

Seller: _____ / _____ Date: _____
(signature) (print)

Buyer acknowledges that **Buyer** has read, understands, and has received a copy of this revised disclosure statement.

Buyer: _____ / _____ Date: _____
(signature) (print)

Buyer: _____ / _____ Date: _____
(signature) (print)

Seller (_____) (_____) and **Buyer** (_____) (_____) acknowledge receipt of a copy of this page, which is Page 5 of 5.

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E. COASTAL A ZONE REQUIREMENTS

The Virginia USBC regulates development in the Coastal A Zone, in accordance with the *2015 International Building Code*. Non-residential structures must be designed in accordance with ASCE 24, the elevation reference point is the bottom of the lowest horizontal structural member, and the foundation must be a pile or column foundation. An engineer's certification of compliance with V Zone standards is required, and breakaway walls are permitted. Dwellings in the Coastal A Zone must comply with the requirements for Zone V, with the exception of stemwalls that are designed to account for wave action, debris impact, erosion, and scour. Breakaway walls are allowed, but must have flood openings, and partitioning of enclosed areas below the lowest floor is not prohibited. Manufactured homes are not regulated by the code.

Norfolk's Zoning Ordinance, in Subsection 3.9.7(K), outlines nine standards for development in the Coastal A Zone. The specific standards that exceed NFIP minimum requirements include:

1. All new construction and substantial improvements shall be elevated on pilings or columns such that:
    a. The bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) is elevated at or above the DFE; and
    b. The pile or column foundation and structure attached thereto is anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously on all building components, where the wind and water loading values are those that each have a 1% chance of being equaled or exceeded in any given year (one-percent annual chance).
2. A registered professional engineer or architect shall develop or review the structural design, specifications and plans for the construction, and shall certify that the proposed design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of subsection (1), above using the Coastal Zone Design Certificate as provided by the City of Norfolk.

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5. For new construction and substantial improvements, the space below the lowest floor shall be maintained free of obstruction and the usage of breakaway walls at or below the DFE is prohibited.
6. The space below the lowest floor shall be used solely for parking of vehicles, building access, or storage. Such space shall not be partitioned into multiple rooms, temperature-controlled, or used for human habitation.

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9. All manufactured homes and recreational vehicles to be placed or substantially improved within VE and Coastal A Zones on the FIRM must meet the standards of subsections (1) though (8), above, and Section 3.9.7.J. General Standards.

DECLARATION OF LAND RESTRICTION (NONCONVERSION AGREEMENT)

FOR USE IN FLOOD HAZARD AREAS FOR PROPOSED DEVELOPMENT THAT INCLUDES (1) ENCLOSURES BELOW ELEVATED BUILDINGS, (2) CRAWL/UNDERFLOOR SPACES THAT ARE MORE THAN 4 FEET IN HEIGHT, AND (3) ACCESSORY STRUCTURES THAT ARE NOT ELEVATED AND ARE LARGER THAN 300 SQUARE FEET IN AREA (FOOTPRINT).

This DECLARATION made this _____ day of _____, 20_____ by _____("Owner") having an address at: _____
_____

WITNESSETH:

WHEREAS, the Owner is the record owner of all that real property located at _____
_____
_____
in the _____the Election District of _____ County, designated in the Tax Records as map _____, parcel _____, plat _____, and being that same property acquired by the Owner by deed dated _____, 20___, and recorded among the Land Records of _____ County, Maryland at liber _____ , folio _____.

WHEREAS, the Owner has applied for a permit to construct a structure on that property that:

(1) Is identified by Permit Number _____ ("Permit");
(2) Is located in a flood hazard area identified on Flood Insurance Rate Map Panel #_____;
(3) Conforms to the requirements of the Floodplain Management Regulations of _____ ("Regulations"); and
(4) May be made noncompliant with the terms and conditions of the Permit by later conversion, modification, or alteration, including such actions by future owners,

WHEREAS, the Owner agrees to record this DECLARATION OF LAND RESTRICTION (NONCONVERSION AGREEMENT) on the deed of the property recorded in the above-cited land records and certifies, accepts, and declares that the following covenants, conditions, and restrictions are placed on the affected property as a condition of granting the Permit, and affects rights and obligations of the Owner and shall be binding on the Owner, his heirs, personal representatives, successors, and assigns.

THE STRUCTURE AUTHORIZED SHALL BE SUBJECT TO CONDITIONS as follows:

1. The structure or part thereof to which these conditions apply is:
   - ☐ An enclosure that is below an elevated building.
   - ☐ A crawl/underfloor space that is more than 4 feet in height.
   - ☐ An accessory structure that is not elevated and that is larger than 300 square feet in area (footprint).

Owner: _____
Address: _____
Permit No. _____

2. Enclosures below elevated buildings, including crawl/underfloor spaces, shall be used solely for parking of vehicles, limited storage, or access to the elevated building. Accessory structures shall be used solely for parking of vehicles and limited storage.

3. If the structure or accessory structure is located in any flood zone designated Zone A (including A, AE, AO, AH, or A1-30), the walls of the enclosure below the lowest floor, including crawl/underfloor space walls, or the walls of the accessory structure, shall be equipped with flood openings as required by the Regulations and the Maryland Building Performance Standards. The flood openings shall not be blocked, covered, or modified in any way that would alter the intended performance to allow floodwaters to automatically enter and exit.

4. If the structure is located any flood zone designated Zone V (including VE or V1-30), the walls of the enclosure below the lowest floor shall be designed to break away as required by the Regulations and the Maryland Building Performance Standards. The breakaway walls shall not be altered or in any way that affects their intended performance under flood conditions.

5. Any conversion, alteration, modification, improvement or change in use of the enclosure below the elevated building, including crawl/underfloor space, or the accessory structure:

a. Shall not occur without the issuance of a permit by the local permit authority; and
b. May require full compliance of the building with the elevation requirements of the Regulations.

6. Any conversion, alteration, modification, improvement or change in use that is not authorized by permit constitutes a violation of the Permit and shall be subject to enforcement action by the local permit authority to correct such violation.

7. Unauthorized conversion, alteration, modification, improvement or change in use of the permitted structure or accessory structure may render the structure uninsurable by the National Flood Insurance Program or increase the cost for flood insurance commensurate with the increased risk.

8. The illegal conversion of an enclosure below the lowest floor or illegal conversion of an accessory structure to habitable uses exposes occupants to increased risk of death and injury. The local jurisdiction issuing the Permit shall not be held liable for any increase in damage or injury to occupants.

9. Other conditions:

_____
_____
_____
_____

Owner: _____
Address: _____
Permit No. _____

SIGNATURES:

OWNER:

In witness whereof the undersigned set their hands and seals this _____ day of _____, 20_____.

Owner _____(Seal)

Owner _____(Seal)

NOTARY:

STATE OF MARYLAND, _____ of _____, TO WIT:

I hereby certify that on this _____ day of _____, 20___, before me the subscriber, a Notary Public of the State aforesaid, personally appeared _____ and _____, known to me, or satisfactorily proven to be the person(s) whose name is subscribed to the foregoing instrument, who acknowledged that he has executed it for the purposes therein set forth, and that it is his act and deed.

In witness whereof, I have set my hand and Notarial Seal, the day and year first written above.

_____

My commission expires on _____

F. HRPDC STORMWATER MOU

ESTABLISHING THE
HAMPTON ROADS REGIONAL STORMWATER MANAGEMENT PROGRAM

WHEREAS, Section 15.2-4200 of the Code of Virginia enables local governments to establish Planning District Commissions; and

WHEREAS, the eighteen local governments that are signatories to this Agreement have acted, in accordance with Section 15.2-4200 of the Code of Virginia, to establish the Hampton Roads Planning District Commission (HRPDC); and

WHEREAS, the HRPDC has been requested and has undertaken various studies to support local government stormwater management programs, including compliance with Virginia Stormwater Management Program (VSMP) Municipal Separate Storm Sewer (MS4) Permits; and

WHEREAS, the signatory local governments have requested the HRPDC to administer and coordinate a regional stormwater management program; and

WHEREAS, pursuant to the Clean Water Act, the U.S. Environmental Protection Agency (EPA) has promulgated implementing regulations, 40 Code of Federal Regulations Part 122, which established the National Pollutant Discharge Elimination System (NPDES) Permits for Municipal Separate Storm Sewer System (MS4) Discharges; and

WHEREAS, pursuant to the Virginia Stormwater Management Act, 62.1-44.15, et. seq. of the Code of Virginia, 1950 As Amended, the Board of Soil and Water Conservation has promulgated implementing regulations 4 VAC 50-60, et. seq., which establish the requirements that localities obtain permits for their MS4 discharges; and,

WHEREAS, the majority of the eighteen signatory local governments are required by their MS4 permits to conduct certain activities, including reporting on their discharges, conducting public information and education programs, and certain other activities; and

WHEREAS, the Water Quality Monitoring and Reporting Act and implementing regulations promulgated by the State Water Control Board establish requirements for the preparation of Total Maximum Daily Load (TMDL) Implementation Plans, which apply to activities conducted by localities in general as well as activities conducted in implementing MS4 permit requirements; and,

WHEREAS, the Chesapeake Bay Preservation Act and the Virginia Erosion and Sediment Control Law and implementing regulations also establish stormwater management requirements that govern one or more of the eighteen signatory local governments; and,

WHEREAS, sixteen local governments and the HRPDC executed the Memorandum of Agreement Establishing the Hampton Roads Regional Stormwater Management

Program on September 5, 2003 and that Agreement expired on December 31, 2007; and,

WHEREAS, eighteen local governments and the HRPDC executed the Memorandum of Agreement Establishing the Hampton Roads Regional Stormwater Management Program on March 6, 2008 and that Agreement expires on June 30, 2013, and

WHEREAS, eighteen local governments and the HRPDC executed the Memorandum of Agreement Establishing the Hampton Roads Regional Stormwater Management Program on July 1, 2013 and that Agreement expires on June 30, 2018.

NOW THEREFORE, the signatory parties enter into the following Agreement.

This Memorandum of Agreement entered into this first day of July 2018, among and between the eighteen local governments in Hampton Roads and the HRPDC, establishes and maintains the Hampton Roads Regional Stormwater Management Program.

BASIC PREMISES

All local governments in Hampton Roads operate stormwater management programs.

The Cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth and Virginia Beach received VPDES Permits in 1996. Those permits, which were renewed in 2001, govern the discharges from their MS4s to waters of the state and impose certain operational and reporting requirements on those systems. In 2005, these permits were converted to VSMP permits. These permits must be renewed on a five (5) year basis and the localities applied for renewed permits in 2005. Localities operated programs under administratively continued permits until June 30, 2016. The new permit became effective on July 1, 2016.

The Cities of Poquoson, Suffolk and Williamsburg and the Counties of Gloucester, Isle of Wight, James City, and York were all identified by the EPA as requiring VPDES permits under Phase II of the MS4 regulations. Those localities that operate MS4s obtained VPDES permits in March 2003. Those permits also imposed certain operational and reporting requirements on those systems. In 2005, these permits were converted to VSMP permits. These permits must be renewed on a five (5) year basis with the next renewal planned for 2013.

It was determined that permit coverage for Isle of Wight County was not required, and the County Phase II MS4 Permit was terminated on April 15, 2016.

Although Gloucester County was initially identified by the EPA as requiring a Phase II MS4 permit, it was subsequently determined that permit coverage for Gloucester County was not required.

The City of Franklin, the Counties of Gloucester, Isle of Wight, Southampton and Surry and the Towns of Smithfield and Windsor are governed by stormwater management

requirements established under the Virginia Stormwater Management Act and the Virginia Erosion and Sediment Control Law. The Chesapeake Bay Preservation Act also governs Gloucester and Surry Counties and the Towns of Smithfield and Windsor.

As of July 1, 2014, all localities have implemented stormwater management programs that meet the minimum requirements established in the Virginia Stormwater Management Act. The Virginia Stormwater Management Act imposes operational and reporting requirements on all localities that are required to implement stormwater management programs.

The local governments are interested in managing stormwater in a manner which protects and does not degrade waters of the state and which meets locally established quality of life goals and objectives. The Clean Water Act and the VSMP require that stormwater quantity and quality be managed to the maximum extent practicable.

In carrying out their stormwater management responsibilities, the aforementioned local governments have developed a consensus on regional goals to guide the operation of their stormwater management programs. Initially, approved by the HRPDC at its Executive Committee Meeting of September 15, 1999, they are:

1. Manage stormwater quantity and quality to the maximum extent practicable (MEP)

    - Implement best management practices (BMP) and retrofit flood control projects to provide water quality benefits.
    - Support site planning and plan review activities.
    - Manage pesticide, herbicide and fertilizer applications.

2. Implement public information activities to increase citizen awareness and support for the program.

3. Meet the following needs of citizens:

    - Address flooding and drainage problems.
    - Maintain the stormwater infrastructure.
    - Protect waterways.
    - Provide the appropriate funding for the program.

4. Implement cost-effective and flexible program components.

5. Satisfy MS4 stormwater permit requirements:

    - Enhance erosion and sedimentation control.
    - Manage illicit discharges, spill response, and remediation.

This Agreement establishes the administrative framework, which will be used by the local governments in Hampton Roads to address certain stormwater management

requirements under the above-cited state and federal laws and regulations.

Eighteen local governments in the Hampton Roads Region will be participants in and signatories to the Agreement.

HRPDC RESPONSIBILITIES

Under the terms of this Agreement, the HRPDC staff is responsible for the following:

- Provide technical support and policy analysis related to stormwater and water quality issues to local government staff.

- Provide the necessary administrative, technical and clerical resources to support program activities in order to ensure that the MS4 permit-holding cities and counties meet applicable stormwater management requirements.

- Prepare an annual work program and budget for the Hampton Roads Regional Stormwater Management Program. The annual work program will be incorporated into the HRPDC Unified Planning Work Program and the annual budget will be incorporated into the HRPDC budget.

- Assist the signatories in coordinating reporting on stormwater related activities to other state and federal agencies to ensure that program requirements are met in a cost-effective manner, which minimizes duplicative reporting and the administrative burden on the signatories.

- Conduct a regional stormwater education program. This will include public education activities and may include outreach to specific economic sectors and groups. The stormwater education subcommittee of askHRGreen.org will be responsible for guiding the development of original materials, including publications, media advertising and promotional items. This may also include development of locality-specific materials or coordination of bulk purchases. The stormwater education subcommittee of askHRGreen.org will coordinate with HRPDC staff on the educational and outreach components of the Hampton Roads Regional Stormwater Management Program.

- Develop and conduct a regional training program for municipal employees, contractors, civic leaders and other interested parties. The training program will emphasize stormwater management, pollution prevention and permit issues.

- Respond equitably and in a timely fashion to requests from all signatory local governments for technical assistance. The time frame for responses will be based on experience, the complexity of individual requests and the overall work load of program staff.

- Provide other technical support, as requested, to the signatory local

governments.

- Upon request from one or more participating localities, conduct technical studies to support compliance by the localities with MS4 permit requirements and VSMP program requirements.

- Facilitate development of multi-jurisdictional management plans for shared watersheds, as requested.

- Take steps, in conjunction with the signatory local governments, to obtain financial support for program activities from outside sources, including state, federal and private grants, to the extent that this may be accomplished without creating a conflict of interest, as determined by the signatory local governments.

- Contract with and manage consultants, including both private firms and academic institutions, to support the regional program, including provision of requested services to local governments in excess of the common program elements.

- Represent the Hampton Roads Regional Stormwater Management Program at federal, state, regional and local governmental, civic, professional and political organizations, agencies, and committees.

- Provide technical and administrative support, as appropriate, to those localities that are required to develop stormwater management programs to meet VSMP requirements, but that are not required to obtain MS4 permits for their stormwater discharges.

- Prepare annual program reports, or components thereof, which comply with the provisions of the MS4 permits and stormwater management programs of the signatory localities.

- Facilitate local government involvement in TMDL studies being prepared through the Virginia Department of Environmental Quality and EPA and facilitate preparation of TMDL Implementation Plans for impaired waters in the Hampton Roads Region as requested.

- Prepare an annual report of activities undertaken through the Hampton Roads Stormwater Management Program. This report will include summaries of related activities undertaken on a cooperative basis by the signatories.

- Identify state and federal regulatory actions that may affect local government stormwater programs, serve on regulatory advisory panels (RAPs) as necessary, conduct policy analysis, and develop policy recommendations on behalf of the HRPDC.

- Coordinate the compilation of regional data for MS4 permit annual reports to the appropriate regulatory authority

LOCAL GOVERNMENT RESPONSIBILITIES

Under the terms of the Agreement, the signatory local governments are responsible for the following:

- Appoint one voting member and alternates, as appropriate, to the Regional Environmental Advisory Committee to represent the local government stormwater and water quality related concerns. Generally, the voting representative should be the MS4 permit or program administrator.

- Appoint a representative and alternates, as appropriate, to the stormwater education subcommittee of askHRGreen.org.

- Provide, in a timely fashion, all locally generated data required by their MS4 permits and such other data as may be necessary to accomplish locally requested services.

- Provide timely technical review of HRPDC analyses and conclusions.

- Participate in regional efforts to conduct public outreach and education activities in regard to the state's TMDL study process and efforts to develop TMDL Implementation Plans for impaired waters lying within the locality or within watersheds that include the locality.

- Provide input on regulatory issues to HRPDC staff and serve on RAPs or provide input to the regional RAP representative as appropriate.

- Support HRPDC efforts to obtain additional funding to support the regional programs, to the extent that this may be accomplished without creating a conflict of interest, as determined by the signatory local governments.

- Provide annual funding to support the agreed-upon regional program.

METHOD OF FINANCING

The majority of program costs will be allocated according to a formula reflecting each locality's share of the regional population. Costs for additional projects or services will be allocated based on a formula developed by the HRPDC staff and approved by the HRPDC with the concurrence of the signatory local governments. For example, legal services have been split between the localities with MS4 permits and the maintenance costs for the regional online BMP database have been split by the subset of localities still using the system.

AVAILABILITY OF FUNDS

Performance by the HRPDC of its responsibilities under this Agreement is subject to the availability of funding from the signatory local governments. Failure of the local governments to provide the necessary funding to support these activities will constitute a Notice to Modify or Terminate the Agreement.

MODIFICATIONS

Modifications to this Memorandum of Agreement must be submitted in writing, approved by the HRPDC, and accepted by all signatories.

DURATION AND TERMINATION

This Agreement will have a term of five years, extending from the date of full execution of the renewed Agreement by the signatories or June 30, 2018, whichever occurs last through June 30, 2023. To conform to local government charter and Virginia Code requirements, the funding provisions of this Agreement will be subject to annual appropriations.

No later than January 1, 2023, the signatories will institute a formal reevaluation of the Hampton Roads Regional Stormwater Management Program. This reevaluation will serve as the basis for appropriate modification of the Agreement and the Hampton Roads Regional Stormwater Management Program.

Any signatory may terminate its participation in the Hampton Roads Regional Stormwater Management Program by written Notice To Terminate to all other parties. Such termination will be effective with the start of the following Fiscal Year. Depending upon the terms of individual VSMP permits, termination of participation in the Hampton Roads Regional Stormwater Management Program in the middle of a permit term may result in changes to permit conditions and require renegotiation of the individual locality's VSMP permit from the state (Virginia Department of Environmental Quality).

OWNERSHIP OF PROPERTY

It is not the intent of the signatories that the Memorandum of Agreement will result in the purchase, ownership, leasing, holding or conveying of any real property.

INDEMNITY

It is the intent of the signatories that no signatory will be held liable for any damage or associated penalties caused by or associated with the failure of any other signatory to discharge its duties or to exercise due diligence in discharging its duties under this Agreement, and that no signatory, by entering this Agreement, waives any defenses or immunities available to it at law, including, but not limited to, those set forth in Section 15.2-970 of the Code of Virginia.

It is the intent of the signatories that no signatory will be held liable for any damage or

associated penalties caused by or associated with the failure of any other signatory to comply with the terms and conditions of the signatory's VSMP permit.

G. SUMMARY OF REGIONAL FLOOD DESIGN STANDARDS

Table A-2 provides a summary of flood design standards currently in place for Norfolk and Virginia Beach in comparison to Virginia's Uniform Statewide Building Code (USBC).

TABLE A-2: SUMMARY OF REGIONAL FLOOD DESIGN STANDARDS*

Regulatory Authority	Freeboard	Coastal A Zone	Repetitive Loss Provision	500-year floodplain restrictions	Manufactured Home Standards	Mitigate Non-Substantial Additions
Virginia USBC	Minimum 1 foot	Requires compliance with some V Zone standards, but not all	X	X	X	X
City of Norfolk	3 feet	✓ (also no breakaway walls)	✓	Elevate 1.5 feet above grade or to 500-year flood elevation	No default elevation to 3 feet above grade	✓
City of Virginia Beach	2 feet	per USBC	X	X	No new MH in Floodway or V Zone	X
U.S. Navy	Minimum 1 foot per ASCE 24	per ASCE 24	X	Protect critical facilities to 500-year flood elevation	Per NFIP minimum requirements	X

*These standards are noteworthy because they exceed NFIP or Virginia statutory requirements. This table is a summary only for comparison purposes and does not show all higher standards. U.S. Navy requires a minimum LEED Silver or equivalent third party certification. LEED requires compliance with ASCE 24 or NFIP plus 500-year elevation for critical facilities.

H. SAN FRANCISCO GUIDANCE FOR INCORPORATING SEA LEVEL RISE INTO CAPITAL PLANNING

GUIDANCE FOR INCORPORATING SEA LEVEL RISE INTO CAPITAL PLANNING IN SAN FRANCISCO: ASSESSING VULNERABILITY AND RISK TO SUPPORT ADAPTATION

Prepared by the City and County of San Francisco

Sea Level Rise Committee

for the San Francisco Capital Planning Committee

Adopted by the Capital Planning Committee on September 14, 2014
Revision Adopted by Capital Planning Committee on December 14, 2015

GUIDANCE FOR INCORPORATING SEA LEVEL RISE INTO CAPITAL PLANNING IN SAN FRANCISCO

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Appendix 4 Sea Level Rise Checklist

EDWIN M. LEE
Mayor

NAOMI M. KELLY
City Administrator

BRIAN STRONG
Director of Capital Planning

ONESF
Building Our Future

CAPITAL PLANNING PROGRAM

Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco
Sea Level Rise Checklist (Version 2.0)

This checklist should be used in conjunction with the SLR Guidance document ("Guidance") for use by City departments to guide the evaluation of capital planning projects in light of sea level rise.

Pre-Checklist check:

The checklist is only required if the following 3 conditions are ALL met. If the answer is 'No' to ANY of these questions, do not complete the SLR checklist. The pre-checklist should be retained for your records.

1. ***Project has a location identified*** *(some projects are so early in planning that they do not yet have a specific location within CCSF)* Yes ____ No ____

2. ***Project is within the SLR Vulnerability Zone*** Yes ____ No ____
(see the Supplementary Document "SLR Vulnerability Zone Map" at: http://onesanfrancisco.org/staff-resources/sea-level-rise-guidance/; contact Hemiar Alburati (hemiar.alburati@sfgov.org) to request a Geodatabase (GIS file) of the SLR Vulnerability Zone Map (overlaid on San Francisco base layers).

3. ***Anticipated total project costs[1] equal or exceed 5 million dollars*** Yes ____ No ____

Department Name:	
Project Name:	
Project ID:	
Name of Project Mgr:	
Name of Preparer:	
Date prepared:	

Only projects answering 'Yes' for questions 1, 2 AND 3 must complete the following checklist.
As noted above, if the answer to questions 1, 2 OR 3 is 'No', the SLR checklist does not need to be submitted. *However, it is recommended that the project manager* ***retain this document in their project records****.*

[1] Project costs include planning, design, and construction costs.

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco
Sea Level Rise Checklist
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SLR checklist – only for projects meeting all 3 pre-checklist conditions above:

Project Information

1.	**What is the project location?** (Please provide the street address or GIS coordinates):
2.	**What type of asset or project is being proposed?** (e.g., new construction, rehabilitation or modification of existing structure, building(s), roadway structure, utility structure, park, etc.):
3.	**What is the remaining or potential future functional lifespan of the project?** *The functional lifespan is the period for which a structure can still meet the purposes for which it was constructed. It refers to the time the asset may realistically be in use at this location, including through one or more repair and maintenance cycles. (See Guidance for more information).* **Remaining or Potential functional lifespan in years:**_____ **Please provide a brief explanation of how this number was arrived at:**
4.	**What is the planning horizon?** (The construction completion year + functional life span = planning horizon year; e.g., (2017 construction completion year + 60 years of functional life span = 2077.) **Planning horizon year:** _____

SECTION I - Vulnerability Assessment for Potential Projects in the SLR Inundation Zone

A. Exposure (see SLR Guidance for additional information):
Using the steps below and SFPUC inundation zone maps or site-specific modeling, please assess if the project site or asset is subject to inundation or temporary flooding during one of the future flood events.

Site Information

Past/Current

5.	**Has the site historically been flooded due to high tides/and or storms?** If yes, please describe conditions: (e.g., King tide, storm surge, rainstorm event)	☐ Yes ☐ No
6.	**What is the lowest ground elevation** at your project location (in feet)? Please select the elevation data used for all calculations (NAVD88 or City Datum): ☐ NAVD88: ☐ City Datum:	(feet) Elevation _____ft

Future Flooding Calculation

7.	**Calculate the sea level rise amounts at the end of the planning horizon year _____ (enter from question 4.)** Use the equations in Appendix 3 of the Guidance to derive the applicable sea level rise: (e.g. for year 2077, upper range SLR in 2077 = 111.79 cm; 44.01 inches; 3.67 ft) a) _____ in inches and _____in feet -- most likely b) _____ in inches and _____in feet -- upper range

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

8. What map/modeling is used for this assessment?

- ☐ SFPUC 2014 Maps and the Supplementary Document "Sea Level Rise Scenario Selection and Design Tide Calculation" found at http://onesanfrancisco.org/staff-resources/sea-level-rise-guidance/
- ☐ Site Specific Modeling (*please provide date and source of information*):

_____

9. What is the Mean Higher High Water (MHHW) elevation closest to your project location? Use the data source in question 8 (e.g., from Figure 1 in Supplementary Document cited in Question 8, which includes maps of the City with tidal data at various points along the shoreline) or site specific modeling).

MHHW Elevation (year 2000):_____ft ☐ NAVD88 ☐CITY DATUM

Assess Project Vulnerability to Permanent Inundation from SLR

10. Subtract MHHW (9) from the Project Elevation (6)

a) Difference in feet: _____ft

A negative number indicates that the project is below MHHW today and is at risk. If the number is positive, this is the amount of sea level rise needed to result in permanent inundation at your project location.

b) Is the Project vulnerable to permanent inundation during the functional lifespan using the most likely SLR scenario? (Yes if the value of question 7a is greater than the value of question 10a).

- ☐ **Yes**: The project is at risk and requires design considerations that address most likely sea level rise.
- ☐ **No**: Not at risk. Go to 10c.

The Project is vulnerable to permanent inundation during the functional lifespan if SLR raises MHHW above the Project Elevation.

c) Is the Project vulnerable to permanent inundation during the functional lifespan using the upper range SLR scenario? (Yes if the value of 7b is greater than the value of 10a)

- ☐ **Yes**: The project may be at risk at upper range SLR. This requires either a finding of adaptive capacity OR identification of adaptation strategies that address upper range SLR.
- ☐ **No**: Assess temporary flooding risk below.

Assess Project Vulnerability to Temporary Flooding from 100-year Coastal Flood

11. What is the 100-year storm surge elevation (in feet) closest to your project location? Use the Supplementary Document cited in Question 8 or site specific modeling. If the project is located directly along the shoreline, the 100-year total water level (which includes wave runup along the shoreline) should also be evaluated.

a) 100-year storm surge elevation (in feet):_____ft ☐ NAVD88 ☐CITY DATUM

Only for projects directly adjacent to the shoreline:

b) 100-year total water level elevation (in feet): _____ft ☐ NAVD88 ☐CITY DATUM

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco
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12. Subtract the 100-year storm surge elevation (11a) from the Project Elevation (6).

a) Difference in feet: _____ft

If the answer is negative, the project is at risk of temporary flooding today by the 100-year storm surge event under existing conditions.

b) Is the answer to Question 12a less than the answer to Question 7a (most likely sea level rise)?

☐ **Yes**: project will be at risk of temporary flooding and requires design considerations that address temporary flooding or an acknowledgement that temporary flooding doesn't result in any impacts
☐ **No**: Not at risk. Go to 12 c.

c) Is the answer to Question 12a less than the answer to Question 7b (upper range sea level rise)?

☐ Yes: The project may be at risk of temporary flooding and requires design adaptation strategies that can reduce potential future risk and/ or the project has inherent adaptive capacity.
☐ No: The project is not vulnerable to SLR/ temporary flooding. Please proceed to Section 3.

13. Only for projects directly adjacent to the shoreline. If project is not adjacent to the shoreline, go to 14.

Subtract the 100-year total water elevation (11b) from the Project Elevation (6).

a) Difference in feet: _____ft

If the answer is negative, the project is at risk of temporary flooding today by the 100-year total water level event under existing conditions.

b) Is the answer to Question 13a less than the answer to Question 7a (most likely sea level rise)?

☐ **Yes**: project will be at risk of temporary flooding due to wave hazards and requires design considerations that address wave hazards or an acknowledgement that wave hazards don't result in any impacts
☐ **No**: Not at risk. Go to 13c.

c) Is the answer to Question 13a less than the answer to Question 7b (upper range sea level rise)?

☐ Yes: The project may be at risk of temporary flooding due to wave hazards and requires design adaptation strategies that can reduce potential future risk and/ or the project has inherent adaptive capacity.
☐ No: The project is not vulnerable to existing or future wave hazards. Please proceed to Section 3.

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

B. Sensitivity (see SLR Guidance for definition):
14. What is the proposed overall sensitivity to flooding and other sea level rise impacts?

- ☐ **Low Sensitivity**: flooding would cause minimal impact; project/ asset(s)/ surrounding infrastructure are able to function during and/or after temporary flooding event
- ☐ **Medium Sensitivity**: flooding would cause medium impact; project/ asset(s)/ surrounding infrastructure would be impacted, but are able to maintain most functions during and/or after temporary flooding event, though repairs may be needed
- ☐ **High Sensitivity**: flooding would result in complete loss of project/asset/surrounding infrastructure or shut-down of operation with high cost and potential impact to health and safety

Please explain briefly*:

*(If more space is required, please provide on separate page).

C. Adaptive Capacity (see SLR Guidance for definition):
15. What is the inherent adaptive capacity to tolerate flooding and other sea level rise impacts or to relatively easily be subsequently adapted to higher levels of SLR should they occur (see Guidance text for explanation)?

- ☐ **High Adaptive Capacity**: ability of the project/asset(s)/surrounding infrastructure to tolerate flooding, moderate potential damages, and cope with the consequences without the need for significant intervention or modification (e.g. alternate infrastructure routes available, elevated structure/site, etc...)
- ☐ **Medium Adaptive Capacity**: ability of the project asset(s)/surrounding infrastructure to tolerate flooding, moderate potential damages, and cope with the consequences with some significant intervention or modification (e.g. modifications, repairs and replacements are possible to restore the function, etc...)
- ☐ **Low Adaptive Capacity**: the project/asset(s)/surrounding infrastructure have limited or no ability to tolerate flooding and/ or inundation, moderate potential damages, and cope with the consequences without significant modification (e.g. no alternate infrastructure routes available, elevation of site not feasible, function can't be restored in that location without replacement, etc...)

Please explain briefly*:

*(If more space is required, please provide on separate page).

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco
Sea Level Rise Checklist
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SECTION 2 – Risk Assessment for Projects vulnerable to SLR per the above

16. What is the anticipated level of **DAMAGE** to the project/ asset(s)?

- ☐ **Low Damage**: Asset(s) could be repaired/ partially replaced
- ☐ **Medium Damage**: Asset(s) would require complete replacement or very costly repairs
- ☐ **High Damage**: Asset(s) would not repairable or replaceable in the existing location
- ☐ Unknown

Please explain briefly*:

17. What is the level of **DISRUPTION**?

- ☐ **Low**: no or little disruption in service or function
- ☐ **Medium**: disruption in service or function that doesn't threaten public health & safety (non-critical)
- ☐ **High**: disruption of service and/or function that threatens public health & safety (critical)
- ☐ Unknown

Please explain briefly*:

18. What are the **COSTS** (to replace/repair or for health & safety)?

- ☐ **Low**: no or little cost to return asset(s) or minor secondary service disruption costs
- ☐ **Medium**: moderate costs to repair/ replace asset(s)
- ☐ **High**: high costs to fully replace asset(s) in new location and/ or high secondary costs attributed to asset being out of service
- ☐ Unknown

Please explain briefly*:

If all answers to Section 2, 15, 16, and 17 are Low, proceed to adaptation planning. If answers are Low and/ or Medium, additional information may be needed to justify certification. If any answers are High, alternatives should be considered.

Please briefly summarize sea level rise adaptation measures associated with this project or program*:

Additional Comments*:

*(If more space is required, please provide on separate page).

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

SECTION 3 – Department Certification Submittal

This section is for the Dept's Director and Deputy Director level only. Please submit signed copy to the Capital Planning Program for processing.

_____ (Dept Name) certifies that the information provided herein is complete and is consistent with CCSF Sea Level Rise Guidance.

Department Director Name (please type/print): _____

Signature: _____ Date: _____

SECTION 4 – Capital Planning Committee

This section is for City Engineer and Capital Planning Committee or Designee completion only.

This project is certified as consistent with the CCSF Sea Level Rise Guidance and

____ will not be exposed to expected SLR and related flooding impacts during its functional lifespan
____ is exposed but is not vulnerable due to low sensitivity or high adaptive capacity
____ is exposed, is vulnerable, but includes sufficient adaptation planning for SLR
____ will require additional adaptation planning

Comments: _____

City Engineer Name (please type/print): _____

Signature[2]**:** _____ Date: _____

Capital Planning Committee Chair Name (please type/print):

_____

Signature: _____ Date: _____

[2] *(Digital Signatures are preferred; if this file needs to be printed and scanned for signatures, please ensure high resolution document print and scan for legibility. Thank you.)*

Department Name: _____ *Project ID (if available):* _____
Date prepared: _____

I. MODEL PROJECT COST ASSUMPTIONS

General Limiting Conditions

AECOM devoted effort consistent with (i) that degree of care and skill ordinarily exercised by members of the same profession currently practicing under same or similar circumstances and (ii) the time and budget available for its work in its efforts to endeavor to ensure that the data contained in this document is accurate as of the date of its preparation. This study is based on estimates, assumptions and other information developed by AECOM from its independent research effort, general knowledge of the industry, and information provided by and consultations with the Client and the Client's representatives. No responsibility is assumed for inaccuracies in reporting by the Client, the Client's agents and representatives, or any third-party data source used in preparing or presenting this study. AECOM assumes no duty to update the information contained herein unless it is separately retained to do so pursuant to a written agreement signed by AECOM and the Client.

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ROM cost estimates were determined based on unit costs, factors and practices obtained from relevant projects and or contractor estimates. The solutions described have not yet been engineered. Estimates of probable cost will change as each project goes through its design process.

TABLE A-3: HELICOPTER ROAD TIDE GATE COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Water Management Infrastructure					
Control Point at Helicopter Road	$500,000	EA	1	$500,000	New Tide Gate Structure on existing Culverts on west side of Helicopter Road
Mobilization Allowance				$10,000	
Subtotal				**$510,000**	
			Contingency	$178,500	35% of subtotal
			Design and Permitting	$61,200	12% of subtotal
			Total	**$750,000**	

TABLE A-4: RIPARIAN PLANTINGS, LAKE BRADFORD – COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Roadway and Landscape					
Riparian Plantings	$15	SF	150,000	$2,250,000	Freshwater littoral plantings along edge of Lake Bradford
Mobilization Allowance				$45,000	
Subtotal				**$2,295,000**	
			Contingency	$800,000	35% of subtotal
			Design and Permitting	$275,400	12% of subtotal
			Total	**$3,370,000**	

TABLE A-5: OPTIONAL PUMP STATION – HELICOPTER ROAD – COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Water Management Infrastructure					
Optional Pump Station	$15,000,000	EA	1	$15,000,000	High capacity pump station
Mobilization Allowance				$300,000	
Subtotal				**$15,300,000**	
			Contingency	$5,355,000	35% of subtotal
			Design and Permitting	$1,836,000	12% of subtotal
			Total	**$22,491,000**	

TABLE A-6: OPTIONAL PUMP STATION – LAKE BRADFORD – COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Water Management Infrastructure					
Optional Pump Station	$6,000,000	EA	1	$6,000,000	Low capacity pump station
Mobilization Allowance				$120,000	
Subtotal				**$6,120,000**	
			Contingency	$2,142,000	35% of subtotal
			Design and Permitting	$734,400	12% of subtotal
			Total	**$8,996,000**	

TABLE A-7: HAMPTON BOULEVARD (NORTH SEGMENT), GLENDALE TO FOREST AVENUE – COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Water Management Infrastructure					
New Stormwater Conveyance	$273	LF	1,511	$412,000	60" reinforced concrete pipes installed
Allowances:					
Tide Gate Retrofit of Existing Outfall	$90,000	EA	1	$90,000	Assume 1 tide gates total
Cleaning and Maintenance of Existing Drainage	$2	LF/Year	$1,511	$3,000	Maintenance for new stormwater conveyance pipes for 1 year of maintenance
Mobilization Allowance				$10,000	
Subtotal				**$515,000**	
			Contingency	$180,000	35% of subtotal
			Design and Permitting	$62,000	12% of subtotal
			Total	**$757,000**	

TABLE A-8: HAMPTON BOULEVARD (NORTH SEGMENT), BAKER TO LEUTZE BOULEVARD – COST ESTIMATE BREAKDOWN

	UNIT COST	UNIT	QUANTITY	COST	ASSUMPTIONS
Water Management Infrastructure					
New Stormwater Conveyance	$188	LF	5,482	$1,031,000	Includes 48"reinforced concrete pipes installed
New Stormwater Storage	$13	CY	5,556	$70,000	Excavation and haul only
New Stormwater Filtration	$120	SF	25,000	$3,000,000	Soil, plantings, and underdrain by Navy Supply Depot Annex
Allowances:					
Tide Gate Retrofit of Existing Outfall	$90,000	EA	2	$180,000	Assume 2 tide gates total
Cleaning and Maintenance of Existing Drainage	$2	LF/Year	5,482	$11,000	Maintenance for new stormwater conveyance pipes for 1 year of maintenance
Mobilization Allowance				$86,000	
Subtotal				**$4,378,000**	
			Contingency	$1,533,000	35% of subtotal
			Design and Permitting	$525,000	12% of subtotal
			Total	**$6,436,000**	

J. LIST OF STAKEHOLDERS

General Stakeholders

City of Norfolk

City of Virginia Beach

Dominion Energy

Hampton Roads Chamber of Commerce

Hampton Roads Military and Federal Facilities Alliance

Hampton Roads Planning District Commission

Hampton Roads Sanitation District

Hampton Roads Transit

Hampton Roads Transportation Planning Organization

JEB Little Creek-Fort Story

Lynnhaven River Now

NSA Hampton Roads

Naval Air Station Oceana/Dam Neck Annex

Naval Station Norfolk

Norfolk International Airport

Norfolk Redevelopment & Housing Authority

Old Dominion University

S.L. Nusbaum Realty

State of Virginia

U.S. Army Corps of Engineers

U.S. Coast Guard

Virginia House of Delegates

Virginia Natural Gas

Virginia Port Authority

Virginia Department of Transportation

K. TABLE OF POTENTIAL FUNDING RESOURCES

TABLE A-9: POTENTIAL FUNDING RESOURCES

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
Local			
1	City of Norfolk CIP Funding	In citywide Capital Improvements Plan.	https://www.norfolk.gov/index.aspx?NID=191
2	City of Virginia Beach CIP Funding	In citywide Capital Improvements Plan.	https://www.vbgov.com/government/departments/budget-office-management-services/budget-archives/Pages/Capital-Improvement-Program.aspx
3	Elizabeth River Trail Foundation	Not-for-profit foundation set up to support the ERT.	http://elizabethrivertrail.org/
Regional			
4	Hampton Roads Transportation Fund Revenue Bonds	Managed by the Hampton Roads Transportation Accountability Commission (HRTAC). HRTF Candidate Projects should meet one or more of the following: be included in the HRTPO Board Approved 2034 Long-Range Transportation Plan (LRTP); be supported by HRTPO Resolutions; be legally eligible; meet Regional Project Cost Threshold of $100 million.	https://www.hrtpo.org/page/hampton-roads-transportation-fund/
State of Virginia			
5	VirginiaSAVES Green Community Program (DMME)	A loan program created to lower financing costs for energy efficiency, renewable energy generation and alternative fuel projects. This low-cost financing tool, available at the link below, is available to local government, institutional and commercial and industrial entities in the Commonwealth.	http://www.vasavesgcp.com/
6	Virginia's Transportation Funding (VDOT, DRPT)	The Commonwealth Transportation Fund receives revenues from dedicated state and federal sources. The major state revenues are based on Virginia's official revenue forecast developed by the Department of Taxation. The Virginia Department of Transportation and the Virginia Department of Rail and Public Transportation estimate the federal revenues from the Federal Highway Administration and the Federal Transit Administration. The SMART SCALE prioritization system determines how funds will be programmed to capital improvement projects through the High Priority Project Program and the Construction District Grant Program.	http://www.virginiadot.org/projects/syip/virginia's_transportation_funding.asp

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
7	Department of Conservation and Recreation (DCR) - Dam Safety and Floodplain Management Grants	The purpose of this category is to assist local governments with flood prevention or protection studies to prevent loss of life and reduce property damage caused by flooding. Per §10.1-603.16 of the Code of Virginia, flood prevention or protection studies means hydraulic and hydrologic studies of floodplains with historic and predicted floods, the assessment of flood risk and the development of strategies to prevent or mitigate damage from flooding.	http://www.dcr.virginia.gov/form/DCR199-219.pdf
8	Stormwater Local Assistance Fund (DEQ)	The purpose of the fund is to provide matching grants to local governments for the planning, design, and implementation of stormwater best management practices that address cost efficiency and commitments related to reducing water quality pollutant loads. Money in the fund may be used to meet: i) obligations related to the Chesapeake Bay total maximum daily load (TMDL) requirements; ii) requirements for local impaired stream TMDLs; iii) water quality requirements of the Chesapeake Bay Watershed Implementation Plan (WIP); and iv) water quality requirements related to the permitting of small municipal stormwater sewer systems. The grants shall be used solely for capital projects meeting all pre-requirements for implementation, including but not limited to: i) new stormwater best management practices; ii) stormwater best management practice retrofits; iii) stream restoration; iv) low impact development projects; v) buffer restoration; vi) pond retrofits; and vii) wetlands restoration.	https://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/StormwaterFundingPrograms/StormwaterLocalAssistanceFund(SLAF).aspx
9	Stormwater Loans (DEQ)	The Virginia Clean Water Revolving Loan Fund (VCWRLF) provides low interest loans to local governments for the construction of facilities or structures or the implementation of best management practices that reduce or prevent pollution of state waters caused by stormwater runoff from impervious surfaces. Applications for VCWRLF Stormwater Loans will be accepted once each year, concurrent with the program's wastewater facility improvement loan applications, which normally occurs in July.	https://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/StormwaterFundingPrograms/StormwaterLoans.aspx
Department of Defense			
10	Community Infrastructure Program	Authorized, but not yet funded.	https://www.defensecommunities.org/blog/tag/defense-community-infrastructure-pilot-program/

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
11	U.S. Navy Funding	Unspecified	https://www.secnav.navy.mil/fmc/fmb/Pages/Fiscal-Year-2019.aspx
12	OEA Implementation Grants	OEA provides grant assistance to state and local governments, and instrumentalities of local governments, as they respond to a Defense industry action, such as base closure or realignment, changes in Defense contracting, or as they address land use compatibility with the military.	http://www.oea.gov/grants
FEMA			
13	National Public Infrastructure Pre-Disaster Hazard Mitigation (Section 1234)	The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. Applicants must demonstrate mitigation projects are cost effective and technically feasible. Authorizes the National Public Infrastructure Pre-Disaster Mitigation fund which will be funded as a 6 percent set aside from disaster expenses, to allow for a greater investment in mitigation before a disaster.	https://www.fema.gov/pre-disaster-mitigation-grant-program
14	Hazard Mitigation Grant Program (Section 404)	Post disaster hazard mitigation funding. (DR-4291 Hurricane Matthew)	https://www.fema.gov/disaster/4291
15	Public Assistance (PA) grant program (Section 406)	Provides supplemental federal disaster grant assistance for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly-owned facilities, and the facilities of certain PNP organizations. The PA program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process.	https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit
16	Flood Mitigation Assistance program (Section 1366)	MA provides funding to States, Territories, federally-recognized tribes and local communities for projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the NFIP.	https://www.fema.gov/flood-mitigation-assistance-grant-program
HRSD			
17	Capital Improvement Program	For projects on HRSD's CIP	https://www.hrsd.com/cip
NOAA			

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
18	The Coastal and Estuarine Land Conservation Program	Lands selected to be protected through the program are ecologically important or possess other coastal conservation values, such as historic features, scenic views, or recreational opportunities.	https://www.coast.noaa.gov/czm/landconservation/
19	Coastal Resilience Grants	This program is intended to build resilience through projects that conserve and restore sustainable ecosystem processes and functions and reduce the vulnerability of coastal communities and infrastructure from the impacts of extreme weather events, climate hazards, and changing ocean conditions.	https://www.fisheries.noaa.gov/grant/noaa-coastal-resilience-grants
USACE			
20	Section 205: Flood Risk Management Program	Local protection from flooding by the construction or improvement of structural flood damage reduction features such as levees, channels and dams. Non-structural alternatives are also considered and may include installation of flood warning systems, raising and/or flood proofing of structures and relocation of flood-prone facilities.	http://www.iwr.usace.army.mil/Missions/Flood-Risk-Management/Flood-Risk-Management-Program/About-the-Program/
21	Section 103: Hurricane and Storm Beach Erosion	This authority allows USACE to assist in the protection of public infrastructure on small beaches against erosion and damages caused by natural storm driven waves and currents. Typical projects include protecting utilities, roadways, and other public infrastructure systems. The maximum federal limit is $10 million per p	http://www.nab.usace.army.mil/Missions/Civil-Works/CAP/
22	Section 14 - Emergency Streambank and Shoreline Protection	Emergency streambank and shoreline protection for public facilities like roads, bridges, hospitals, schools, and water/sewage treatment plants that are in imminent danger of failing..	http://www.nab.usace.army.mil/Missions/Civil-Works/CAP/
23	Section 107: Navigation Improvements	Improvements to navigation including dredging of channels and widening of turning basins for commercial navigation improvements. May also include the construction of breakwaters, jetties and groins. The Corps does not participate in the cost of dredging berthing areas, slip space, access to individual private docks or the construction of piers, ramps and other shore facilities	http://www.nab.usace.army.mil/Missions/Civil-Works/CAP/

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
24	2018 USACE Supplemental Appropriation	$4.7 billion may be used for projects in states that have had more than one major disaster declaration between 2014 and 2017. Hampton Roads was declared by Hurricane Matthew in 2016.	https://www.congress.gov/bill/115th-congress/house-bill/601/text
USDOT			
25	National Infrastructure Investments-BUILD Transportation Planning Grants	Planning, preparation, or design—including environmental analysis, feasibility studies, and other pre-construction activities: Eligible projects for BUILD Transportation Discretionary Grants are capital projects that include, but are not limited to: (1) highway, bridge, or other road projects eligible under title 23, United States Code; (2) public transportation projects eligible under chapter 53 of title 49, United States Code; (3) passenger and freight rail transportation projects; (4) port infrastructure investments (including inland port infrastructure and land ports of entry); and (5) intermodal projects.	https://www.transportation.gov/BUILDgrants
26	Recreational Trails Program (FHWA)	The Recreational Trails Program (RTP) provides funds to the States to develop and maintain recreational trails and trail-related facilities for both non-motorized and motorized recreational trail uses. The RTP is an assistance program of the Department of Transportation's Federal Highway Administration (FHWA).	https://www.fhwa.dot.gov/environment/recreational_trails/
27	Construction of Ferry Boats and Ferry Terminal Facilities Program (FHWA)	Federal-aid highway funds are available, through the State transportation agencies, for designing and constructing ferry boats and for designing, acquiring right-of-way, and constructing ferry terminal facilities. Ferry boats and terminal facilities that serve vehicular travel as links on public highways (other than Interstate highways), as well as ferry boats and terminals only serving passengers as a fixed route transit facility, may be eligible for certain types of Federal-aid highway funding.	https://www.fhwa.dot.gov/specialfunding/fbp/

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
28	National Highway Performance Program (FHWA)	The FAST Act continues all prior NHPP eligibilities, and adds four new eligible categories: (1)Installation of vehicle-to-infrastructure communication equipment [23 U.S.C. 119(d)(2)(L)]; (2)Reconstruction, resurfacing, restoration, rehabilitation, or preservation of a bridge on a non-NHS Federal-aid highway (if Interstate System and NHS Bridge Condition provision requirements are satisfied) [23 U.S.C. 119(i)]; (3)A project to reduce the risk of failure of critical NHS infrastructure (defined to mean a facility, the incapacity or failure of which would have a debilitating impact in certain specified areas) [23 U.S.C. 119(j)(3)]; (4) At a State's request, the U.S. DOT may use the State's STBG funding to pay the subsidy and administrative costs for TIFIA credit assistance for an eligible NHPP project or group of projects. [23 U.S.C. 119(h)].	https://www.fhwa.dot.gov/fastact/factsheets/nhppfs.cfm
29	Transportation Alternatives Set-Aside (FHWA)	Generally, TA eligibilities are the same as those under the prior TAP, except the FAST Act newly allows an urbanized area with a population of more than 200,000 to use up to 50% of its suballocated TA funds for any STBG-eligible purpose (but still subject to the TA-wide requirement for competitive selection of projects); and [23 U.S.C. 133(h)(6)(B)] eliminated TAP's "Flexibility of Excess Reserved Funding" provision (which allowed the use of excess TAP funds for any TAP-eligible activity or for projects eligible under the Congestion Mitigation and Air Quality Improvement Program).	https://www.fhwa.dot.gov/fastact/factsheets/transportationalternativesfs.cfm
30	Defense Access Road Program (FHWA)	The Defense Access Road (DAR) Program provides a means for the military to pay their share of the cost of public highway improvements necessary to mitigate an unusual impact of a defense activity. An unusual impact could be a significant increase in personnel at a military installation, relocation of an access gate, or the deployment of an oversized or overweight military vehicle or transporter unit.	https://flh.fhwa.dot.gov/programs/dar/

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
31	Congestion Mitigation and Air Quality Improvement Program (FHWA)	Funds may be used for a transportation project or program that is likely to contribute to the attainment or maintenance of a national ambient air quality standard, with a high level of effectiveness in reducing air pollution, and that is included in the metropolitan planning organization's (MPO's) current transportation plan and transportation improvement program (TIP) or the current state transportation improvement program (STIP) in areas without an MPO.	https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm
32	Passenger Ferry Grant Program, Section 5307	Funding is made available to designated recipients, eligible direct recipients of Section 5307 funds, States and federally recognized Tribes that operate a public ferry system in an urbanized area.	https://www.transit.dot.gov/passenger-ferry-grants
U.S. EPA			
33	National Wetland Program Development	The U.S. Environmental Protection Agency (EPA) is soliciting proposals from eligible applicants for projects that develop or refine state/tribal/local government wetland programs as a whole, or individual components of those programs. Proposals for projects submitted under this announcement for Wetland Program Development Grants (WPDGs) must address the National Priority Area identified in Section I.B of the announcement.	https://www.epa.gov/sites/production/files/2018-05/documents/hq_fy18-19_wpdg_rfp_-_08_may_2018_final.pdf
34	Clean Water Act Nonpoint Source Grant (Section 319 Grants)	Clean Water Act Section 319(h) funds are provided only to designated state and tribal agencies to implement their approved nonpoint source management programs.	https://www.epa.gov/nps/319-grant-current-guidance
35	Drinking Water State Revolving Fund	The Drinking Water State Revolving Fund (DWSRF) program is a federal-state partnership to help ensure safe drinking water. Created by the 1996 Amendments to the Safe Drinking Water Act (SDWA) the program provides financial support to water systems and to state safe water programs.	https://www.epa.gov/drinkingwatersrf
36	Clean Water State Revolving Fund	The Clean Water State Revolving Fund (CWSRF) program is a federal-state partnership that provides communities a permanent, independent source of low-cost financing for a wide range of water quality infrastructure projects (can be used to construct wetlands).	https://www.epa.gov/cwsrf

TABLE A-9: POTENTIAL FUNDING RESOURCES (continued)

NUMBER	PROGRAM	ELIGIBILITY	QUANTITY
U.S. FWS			
37	North America Wetlands Conservation Act 2019-2 U.S. Standard Grants	The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the North American Wetlands Conservation Act. Projects must involve only long-term protection, restoration, enhancement and/or establishment of wetland and associated upland habitats to benefit migratory birds. The program requires a 1:1 non-federal match and research funding is ineligible. This program supports the DOI and FWS mission of protecting and managing the nation's natural resources by collaborating with partners and stakeholders to conserve land and water and to expand outdoor recreation and access.	https://www.fws.gov/birds/grants/north-american-wetland-conservation-act/how-to-apply-for-a-nawca-grant.php
U.S. HUD			
38	CDBG Entitlement Program	CDBG funds may be used for activities which include, but are not limited to: 1. Acquisition of real property 2. Relocation and demolition 3. Rehabilitation of residential and non-residential structures 4. Construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes 5. Public services, within certain limits 6. Activities relating to energy conservation and renewable energy resources	https://www.hudexchange.info/programs/cdbg-entitlement/cdbg-entitlement-program-eligibility-requirements/

L. TABLE OF SANITARY PUMP STATIONS INCLUDED IN ACCESS ANALYSIS BY OWNERSHIP

TABLE A-10: SANITARY PUMP STATIONS INCLUDED IN ACCESS ANALYSIS BY OWNERSHIP

OWNER	TOTAL # OF PS INCLUDED IN ORIGINAL ANALYSIS	IN ZONE AE	IN ZONE VE	MINOR TIDAL FLOODING, 0' SLR	MINOR TIDAL FLOODING, 1.5' SLR	MINOR TIDAL FLOODING, 3' SLR
City of Norfolk	137	58	2	4	12	29
City of Virginia Beach	434	88	0	4	9	29
Commonwealth of Virginia	16	3	1	0	0	0
Hampton Roads Sanitation District	37	19	1	0	7	15
Private	283	58	3	2	12	28
Military	9	1	0	0	0	1
Total	**916**	**227**	**7**	**10**	**40**	**102**

Data Sources: City of Norfolk; City of Virginia Beach; Hampton Roads Sanitation District, 2019.

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